GGDC RESEARCH MEMORANDUM *161*

FROM CONVERGENCE TO DIVERGENCE: PORTUGUESE DEMOGRAPHY AND ECONOMIC GROWTH, 1500-1850

Nuno Palma and Jaime Reis

September 2016

university of groningen / groningen growth and development centre

FROM CONVERGENCE TO DIVERGENCE: PORTUGUESE DEMOGRAPHY AND ECONOMIC GROWTH, 1500-1850[1]

Nuno Palma

Department of Economics, Econometrics, and Finance, University of Groningen

Jaime Reis

ICS, Universidade de Lisboa

Abstract

We construct the first time-series for Portugal's per capita GDP for 1500-1850, drawing on a new and extensive database. Starting around 1550 there was a highly persistent upward trend of per capita income, which accelerated after 1700 and peaked 50 years later. At that point, per capita incomes were high by European standards. But as the second half of the eighteenth century unfolded, a phase of economic decline was initiated. This continued into the nineteenth century, and Portugal found itself as one of the most backward European economies precisely at the dawn of the era of modern economic growth.

This version: September 13th, 2016

Keywords: Early Modern Portugal, Historical National Accounts, Standards of Living Debate, The Little Divergence, Malthusian Model

JEL codes: N13, O52

[1] We are grateful to Steve Broadberry, Leonor F. Costa, António C. Henriques, Kivanç Karaman, Wolfgang Keller, Şevket Pamuk, Leandro Prados de la Escosura, Joan R. Rosés, Jeffrey Williamson, and many participants at the Nova SBE lunchtime seminar, the 2014 Accounting for the Great Divergence conference, The University of Warwick in Venice, the 2014 APHES conference in Lisbon, and the 2015 EHES in Pisa for discussion of this paper. We also thank colleagues on the Prices, Wages and Rents in Portugal 1300-1910 project. This paper partly relies on previous joint work with Leonor Costa and Conceição Andrade Martins, to whom we owe special thanks. We acknowledge the help of Hermínia Barbosa, Cristina Giesteira and Carlota Santos for giving us access to their parish registers data. We are also grateful to Paulo Paixão for dedicated research assistance in collecting much of the raw demographic data. Finally, we thank FCT for financial support for this project.

1. Introduction

The effort to understand the historical origins of modern economic growth necessarily involves paying attention to the European periphery. Understanding what "went wrong" in the periphery is a crucial part of the effort to make sense of what "went right" in Northern Europe. Knowing how prices, rents, income and population evolved in the countries that lagged behind is a critical piece of the puzzle, as it provides a source of variation in the data which allows us to compare them with the modernizing economies. The behavior of such major macroeconomic variables during the early modern period is now well known for England, Holland, Germany, Sweden, Italy, and Spain.[2] In this study, we consider the case of Portugal, which has so far been absent from the literature.

In this paper we present the first annual estimates of Portugal's early modern GDP per capita, real wages and population. In Figure 1, we show indices for these variables for the period 1500-1850. Portugal's early modern performance was characterized by several distinctive phases. The first was a period of decline from the high levels in the standard of living seen at the beginning of the sixteenth century, which lasted until the 1550s.[3] This was followed by extensive and intensive growth, which lasted until the mid-seventeenth century. From then on and until the early eighteenth century there was a slight drop in per capita GDP. This was followed in the half century after 1700 by strong intensive growth; as a result Portugal's 1750s per capita GDP came to be almost as high as that of England or the Netherlands.[4]

This economic experience is especially striking in light of the statement by Broadberry et al (2015, p. 212) that in Britain, "[In the period 1780-1830] for the first time the Kuznets condition of simultaneous growth of both GDP per head and population was being met". As Figure 1 shows, Portugal in fact went through two earlier episodes of this nature, both of which were rather prolonged: one from about 1550 to 1650, and another from about 1700 to the 1750s. Once past the 1750s, however, the sources of this expansion began to peter out. Economic performance slowed down but population grew strongly, and in sixty years all of the recent GDP per capita and real wage gains were wiped out. Thereafter income per person continued to decline, with the consequence that by the middle of the nineteenth century Portugal became one of the most backward economies of Europe, precisely as the era of modern economic growth was beginning in other countries.[5]

Portugal's population rose by a factor of four during these three and a half centuries. It displayed marked fluctuations, though with quite a different timing from that of the real economy. During the roughly two centuries after 1550, it too expanded strongly but was never able to keep up with the growth of the economy. In contrast, as the latter slowed down during the century which followed the 1750s, population growth gathered speed – at an annual rate of increase of 0.4 percent – and thus contributed significantly to the erosion of real per capita incomes.

---

[2] See, for England, Allen (2001), and Broadberry et al (2015); for Holland, van Zanden and Leeuwen (2012); for Germany, Pfister (2011), and Pfister et al (2012); for Sweden, Edvinsson (2013a, b) and Schön and Krantz (2012); for Italy, Malanima (2011, 2013); and for Spain, Álvarez-Nogal and Prados de la Escosura (2007, 2013).

[3] See Reis (2016, p. 188, fnt. 34) for a discussion of the severe agricultural crises of this period.

[4] In the 20-year period between 1703 and 1723, Portugal's per capita income grew by an average of 1.4% per year – a remarkable rate for a pre-modern economy.

[5] Around 1850 Portugal's per capita GDP was close to the levels of the Scandinavian countries, and higher than Greece and southern Italy (Reis 2000).

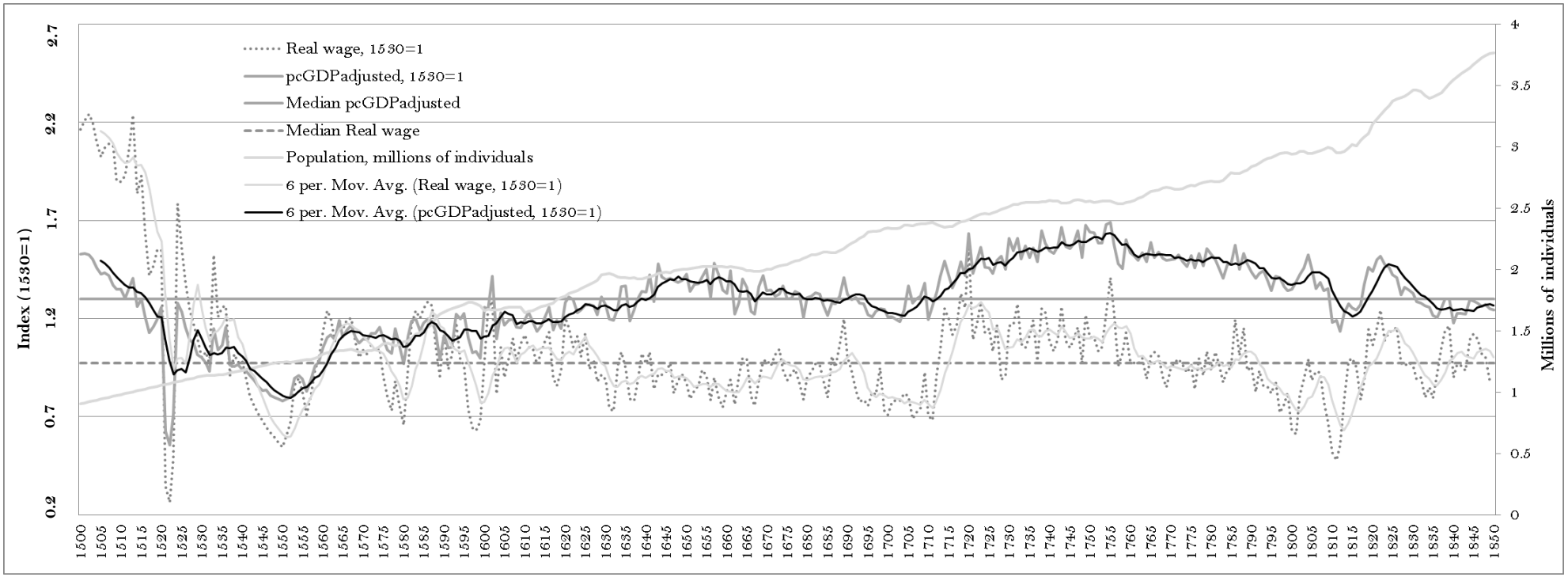

Figure 1. Portugal's GDP per capita, real wage (left scale, unit: index 1530=1) and population (right scale, interpolation 1500-1529, annual variation since 1530, unit: millions of individuals), 1500-1850. Sources: for GDP and real wage, see text, for population: see text and Palma and Reis (2015).

In a recent summary of the state of the art, Grafe (2015) singles out several issues regarding the dynamics of European early modern economies. These raise doubts about a number of established facts in this field. In the present study, we seek to clarify some of the most important ones using Portugal's historical experience to this end. The first questions the "dogma of a largely stagnant early modern European economy" (Grafe 2015, p. 280). This requires attention being paid to the significant bouts of expansion driven by technical and organizational change underwent by Portugal in this era. The second queries the country's adherence to the canonical Malthusian model, particularly during spells when income deviated persistently from the Malthusian subsistence level and Ricardo's iron law of wages broke down. The third confronts the conventional vision of the geography of a Little Divergence during which early modern European growth was 'restricted to the North Sea region … while per capita income in the rest of Western Europe was constant at best' (Van Zanden 2009, p. 5).[6] The fourth focuses on the notion of a "premodern intensive growth" process. In it, repeated divergence from the stagnation equilibrium occurs in the presence of sequential sources of growth, but reversals can also happen at any time.

To achieve these goals, we carry out two fundamental tasks. One is to provide a thorough national accounting exercise regarding Portugal's early modern economy. The other is to supply explanations for the proximate causes underlying both the process of Portugal's economic growth, and its subsequent reversion into the nineteenth century.[7]

2. Data and analytic tools

In this section we discuss the data employed in this article to construct the macroeconomic variables required by our analysis. Our aim is to obtain long-term annual series for population and occupational shares, land, wages, agricultural and manufacturing price indices, and land rents. These are then combined to generate a number of essential analytic tools such as real wages, GDP and GDP per capita, agricultural and manufacturing TFP, as well as rent-wage and land-labor ratios.[8] The basic procedures followed are standard in the early modern macroeconomic literature.

2.1. Data

We use long-term annual series for the following variables: population, land, wages, agricultural and manufacturing prices, and land rents.[9] The set of prices that we use has been put together in accordance with the methodological criteria adopted in similar studies. They must be representative of the national economy and reflect the value of market transactions. They should also arise chiefly from the accounts of large and efficiently-run institutions which were capable of producing reliable, high-frequency information. In our case, given the small size of the country we restrict ourselves to Lisbon and its rural surroundings. We thus adopt the principle of the "national representativeness" of the data regarding the country's principal city (Allen 2001).[10] Prices have been normalized to correspond to metric units. We make sure they allow us to construct a consumption basket which is comparable to those used in parallel pro-

[6] A more recent version of this standard account is Broadberry et al. (2015)'s description of an early modern 'little divergence' between the countries of Northern and Southern Europe; see also Fouquet and Broadberry (2015).
[7] We do not discuss in detail matters related to human capital, economic geography, and political institutions.
[8] A data file with all the variables we construct in this paper will be made available online in due course.
[9] A major research project (PWR- Prices, wages and rents in Portugal, 1300-1910) supports our present study: http://pwr-portugal.ics.ul.pt/. This is the source of all the price and wage data used here, as well as of a companion paper (Reis 2016).
[10] See Reis (2016) for the justification of this option in the case of Portugal.

jects for other countries. Owing to a relative scarcity of data, we have had to interpolate a certain portion of them, mostly in the sixteenth century.[11]

To represent the cost of a unit of the factor labor we have chosen the daily unskilled wage of male adult workers. This allows us to capture the value of the raw labor in a well identified unit of services and avoid distortions caused by variation in the unidentified presence of human capital in the labor stock.[12] These wages refer always to employment in either agriculture or the building industry and to situations in which non-monetary complementary remunerations were absent.

As far as prices for the agricultural sector are concerned, we have selected those corresponding to the principal articles of consumption and production. Consumables include wheat and maize bread, meat, olive oil, wine, eggs and hens, all of which, in the literature of the early modern period, form part of the widely accepted standard consumption basket. From the production side, we take the prices of charcoal, linen cloth, soap and candles.

Land rents have attracted little attention from the economic historians of this period in Portugal. In fact, rents are important for the present narrative as indicators of the value of the services produced by land and as an indicator of its relative scarcity. At this time, most land in use was not directly cultivated by its lords. Possibly a little less than half of all agricultural land was rented out on terms of commercial tenancy, with leases typically running from three to ten years (Monteiro 2005). The remainder was held under long term or perpetual emphyteutic contracts, whereby the lord received a fixed fee and the tenant enjoyed a de facto assignable right to the exclusive enjoyment of all the fruits of the land (Costa et al 2016; Fonseca and Reis 2011).[13] We assume that the rent of the first category of contracts provides a reliable indication of the market value of all agricultural land per hectare. Data for land rents are not abundant. We value them by means of an indicator based on the aggregate rent of a time-invariant set of thirty-two estates owned and regularly leased by a charitable institution in the southern region of Alentejo (Santos 2003). Since this only covers the years from 1595 to 1850, we fill in the rest of the sixteenth century from other comparable sources.[14]

Palma and Reis (2015) have constructed the first annual series for Portugal's population during this period, using a combination of stocks from censuses and population counts, and flows from the parish registers of several dozens of parishes. The result is the gray line in Figure 1. This estimation is inspired by the seminal work on England by Wrigley and Schofield (2010/1989) and Wrigley et al (1997), which offers a number of advantages over their exercise. We leave to that paper the details regarding the reconstruction of population, but we provide a summary in the online Appendix to the present paper.

Finally, we provide a measure of total agricultural land, a considerable challenge for the study of any economy during the early modern period. The solution generally employed in the literature assumes that, despite changes over the last few hundred years, the number of hectares in agrarian use has not changed much up to the present day. From this perspective, what matters is the potential resource base, and upgrades to quality or changes of usage are hence assigned to changes in technology. In the case of Britain, this has been defended on the grounds that practically all land had been put to use by 1066 (O'Rourke and Williamson 2005).

[11] We show the percentage of the yearly variation of the principal data that is covered by our sources in Table A1 of the online Appendix.
[12] Costa, Palma and Reis (2015) show that the skill premium was roughly constant over the early modern period.
[13] While the first of these arrangements was employed mostly for larger units of production, the latter corresponded to small or minuscule farms.
[14] For details, see Reis (2016).

The same rule of thumb has been adopted for Europe as a whole, from 1300 to 1800, by Allen (2003). We follow this approach for Portugal, where we suppose that by 1500 all utilizable land was under some form of usage. We thus assume the stock of land as equal to the area of "agricultural land" measured by the United Nations-Food and Agriculture Organization in the 1950s, namely 4.13 million hectares.[15]

2.2. Real wages

To obtain real wages for Portugal, we convert nominal wages by employing the procedure followed in Reis (2016) and originally outlined by Allen (2001). We use a CPI defined by the silver price of a basket with a composition of goods assumed to represent the consumption needs of a Strasbourg pre-modern 'respectable' working class family. We make several adaptations to this formula, as required by differences in preferences and geography, whilst taking care that the caloric and protein standards are not significantly altered. The most important of them is that dictated by the remarkable shift in bread consumption from wheat to maize (i.e. American corn) flour which occurred during the period of this study. This is taken into account by altering the annual grain content of the CPI in accordance with the information on production shares based on tithes (Oliveira 1990, 2002).[16] Other changes to the original basket are the replacement of beer by wine, butter by olive oil, and cheese by hens. The resulting long term real wage for Portugal is shown in Figure 1.

2.3. GDP per capita

The early modern economic history literature has embraced the real wage as a valuable measure for international and inter-temporal assessments of living standards (Allen 2003, Pfister et al 2012). On the other hand, a real wage trend suggesting long run stagnation does not necessarily mean that this will in fact happen to overall income and welfare levels. In the well-studied English case, for instance, real wages conform to such a picture for the entire early modern period (Allen 2001, Clark 2007, 2010), yet this is not confirmed by output-side GDP estimates, which show substantial intensive growth (Broadberry et al 2015).

This points towards a recognition that GDP per capita should be preferred, as a measure of overall well-being, to the real wage. In the literature, two ways have been employed for estimating the former variable in the case of premodern economies. One requires abundant production data, and has been employed in the cases of England/UK and the Netherlands (Broadberry et al 2015; Van Zanden and Van Leuween 2012). In countries like Portugal, however, where output data is scarce, one has to rely on simpler demand-based methods as has been done in the cases of Spain, Italy, Sweden and Germany (Álvarez-Nogal and Prados de la Escosura 2013, Malanima 2011, Schön and Krantz 2012, Pfister 2011). They consist of two main stages. In the first, it is assumed, unrealistically, that all workers were employed the same number of days per year in every year considered. Álvarez-Nogal and Prados de la Escosura (2013), improve on this first step by calculating agricultural output on the basis that income was derived from not only labor but also land. In the present instance, we go further by using supply-side evidence in order to adjust the labor supply variable and thus correct the demand-side estimate for agricultural output. The second stage is to gauge the size of the non-

[15] "Agricultural land" is defined as the sum of crop producing land, meadow land, pasture and rough grazing. In pre-industrial times this would have included a sizeable portion of fallow land in crop rotation. The earliest available contemporary evidence for Portugal comes in a calculation made in 1875 by the geographer Gerardo Pery, who assessed the total "productive area" - thus excluding forests - as being 4.34 million hectares (Fonseca 1996).
[16] This procedure mitigates some of the traditional problems with PPPs (Deaton and Heston 2010, p. 12; Allen 2013). For a recent discussion on the merits of tithes as indicators of agricultural growth, see Álvarez-Nogal et al. (2016) and Reis (2016).

agricultural sector, either by retropolating it from statistical information pertaining to post-early modern urban industrial activity, or by assuming a productivity gap, which is the option we take here.

2.3.1. Demand-side estimates: agriculture

Portugal's agricultural product over this period has been estimated by Reis (2016). Here we provide a short summary of the procedure, which we also improve upon. The first part of the exercise uses a demand-for-food function to obtain gross agricultural output, which is taken to be equal to food consumption (Wrigley 1985, Allen 2001) given the practical equivalence between them in the Portuguese case.[17] For any given year, the agricultural product (Q_a) is given by the expression,

$$Q_a = P^{\alpha} I^{\beta} M^{\chi} N$$

in which P is the real price of agricultural products, I is real income per capita, M is the real price of other consumer goods and N is total population. The coefficients α, β and χ are, respectively, the own price, income and cross elasticities of demand. This function takes into account the impact on food consumption of fluctuations in real income, food prices and non-food prices, as well as their respective elasticities.

A fairly wide range of choices exists with regard to the selection of demand and income elasticities. In the absence of anything better, the literature has resorted to emulating the present day elasticities of less developed economies with traits presumed similar to those of early modern economies. The possibilities go from -0.4 to –0.7, for own-price elasticity, and from 0.3 to 0.6 for income elasticity. We have found the arguments advanced by Álvarez-Nogal and Prados de la Escosura (2013) convincing and have therefore opted here for the set they propose in which α = -0.4, β =0.3 and χ =0.1.

The principal difficulty with this model is how to quantify the real income variable. The best solution to date is that proposed by Álvarez-Nogal and Prados de la Escosura (2013, p. 9), which employs a weighted index of annual wages (0.75) and land rents (0.25). We use a more precise method, by summing yearly the actual current-price wages and rents derived from our primary sources, and building an index which we then deflate using a CPI.[18]

2.3.2. A labor supply adjustment

In order to reflect the true number of days worked per year we now apply a supply-side adjustment to the preceding estimate. There is evidence that working days per year increased over this period in Portugal, as they did elsewhere in Europe. The country experienced something akin to an 'industrious revolution' in the countryside as a response to more-labor intensive agricultural methods required by the gradual introduction of maize and wine (Ribeiro 1986), and in response to the economic opportunities offered by the empire (Costa, Palma and Reis 2015). As a result, the growth of income was bound to be higher than that suggested by

[17] The online Appendix (table A2) shows the very small size of the differential between food imports and exports and compares it to agricultural output. See Costa and Reis (2016).

[18] The literature usually sets at 250 the number of days worked in a year. In a predominantly rural economy, which is subject to pronounced seasonality, this may seem large, though less so for proto-industrial workers and perhaps not at all for workers in cities. For our baseline estimates, we prefer a weighted index of unskilled laborers earning the corresponding wage and working 120 days a year; skilled urban laborers, who worked 250 days and earned skilled wages; and rural non-agricultural workers, who are presumed to have been employed 180 days a year and earned a rate equal to the mean of the unskilled and the skilled wages.

real wages calculated under the assumption of fixed labor supply per worker, using the nominal day wage.

We propose the following novel solution to this problem. We begin by selecting two moments for which independent supply-side GDP estimates are available. These are conveniently located at the two extremities of our period: 1515 (Godinho 1968-72) and 1850 (Reis 2000). For each of these points in time, we convert total output at current prices into tons of silver. The respective amounts can then be compared with the analogous amounts calculated from the demand side. Using an initial number of 168 days per worker (as in Álvarez-Nogal and Prados de la Escosura 2013), we find that for 1515 the ratio of GDP established from the demand side to that calculated from the output side is 1.09. The same exercise for 1850, however, leads to a ratio of 1.47. We thus conclude that over this period the average days worked must have increased to 248, which is the number needed to conciliate the two GDP estimates, from the demand and the supply sides.[19] To complete this adjustment, we split this extra labor effort into yearly variations over the entire period. We use as an indicator for this the share of maize in total grain production based on tithes received by the bishopric of Viseu from the sixteenth to the nineteenth centuries (Oliveira 1990, 2002).[20]

2.3.3. Demand-side estimates: the non-agricultural sector

The second major step in estimating GDP is the quantification of the non-agricultural part of the economy. Both Malanima (2011) and Álvarez-Nogal and Prados de la Escosura (2013) have postulated a significantly stable relation between the urban share of the population and the size of the secondary and tertiary sectors together. The former has extrapolated this link all the way back to 1300 using the coefficients of a linear regression covering the years 1861-1936. In it, non-agricultural output was the dependent variable and aggregate trade and industry served as the covariate. The latter simply used change over time in the country's "adjusted" urbanization rate to "proxy those in non-agricultural output per capita" (2013, p. 14).

Both approaches have disadvantages, the principal one being that focusing on urban production alone entails ignoring the contribution of proto-industry to non-agricultural production. Another is that they overlook the more than likely rise in productive efficiency which arose in parts of the economy during the preindustrial era. To surmount them, we resort to the procedure proposed by Pfister et al (2012) for Germany by assuming a constant ratio between the share of agriculture in total output and its share of employment. In other words, we maintain that the inter-sectoral productivity gap (p) between agriculture and total output is time-invariant over the period considered.[21] The expression for GDP at any given year t is then,

$$GDP_t = Q_{a,t}/(p \times \frac{L_{a,t}}{L_t})$$

[19] The corresponding increase, assuming proportionality, for each labor type is as follows: 120 to 177 for agricultural workers, and 180 to 265 days for semi-skilled laborers. For urban skilled laborers we have truncated the increase at 320 days (from an initial level of 250). Part of the increment may be due to a combination of an increase in labor supply at both the intensive level (the same cohorts of people work more days) and at the extensive level (more people from the same cohorts substitute leisure for agricultural production or enter the rural skilled or urban labor markets). In the online Appendix (Figure A1) we report the non-adjusted estimates, which also show intensive growth, though slightly weaker.

[20] The first reliable observation corresponds to just over 20% in 1701. We hence assume a level of 0.1% in 1600, and interpolate linearly until 1701. The resulting values closely match a few partial observations we have for the seventeenth century: for instance, under our procedure we assume about 13% for 1665, while the true value was around 15% (Oliveira 1990). This data is discussed in more detail in section 3.1.

[21] In the online Appendix, we offer an additional discussion of the intersectoral productivity gap and offer a robustness check where we allow it to vary endogenously over time (Figure A2). The main results hardly change.

in which $Q_{a,t}$ is agricultural output and $L_{a,t}$ and L_t are agricultural and total labor respectively, all of them at time t, and p is the constant productivity gap. Since we possess estimates of agricultural output (Reis 2016) and of major sectoral shares (discussed next), all that is needed to derive GDP is to determine this gap at a point in time for which this is possible and then extrapolate the desired result back as far as needed. We resort to an estimate for Portugal of p from the mid-nineteenth century (1850)[22] which is of a credible order of magnitude. It is lower than those for Italy (Malanima 2011) and Germany (Pfister 2011) and similar to the value derived for Spain (Álvarez-Nogal and Prados de la Escosura 2007).[23] The expression for obtaining the value of p is,

$$p_{1850} = \frac{Q_{a,1850}/Q_{na,1850}}{L_{a,1850}/L_{na,1850}}$$

where $Q_{a,1850}$ is agricultural output, $Q_{na,1850}$ is non-agricultural output and $L_{a,1850}$ and $L_{na,1850}$ are, respectively, the total labor of these two sectors, at the year 1850. The value we adopt for Portugal is 0.7, the mean of those obtained from data found, respectively, in Lains (2003) and Reis (2005).

2.3.4. Occupational distribution and structural change

We now briefly discuss the characteristics of Portugal's occupational distribution and structural change over this period.[24] The first step is to estimate urban population, and the main economic activities in which the population was engaged. We split the population simply between the agricultural and the non-agricultural sectors. Evidently, the rural and urban non-agricultural components both encompass manufacturing, transport, trade and administrative activities wherever carried out, but because of lack of information, we are unable to consider these distinctions. For assessing the urban part of the population, we rely on the well-known Bairoch (1986) dataset, but have interpolated the "missing" inhabitants at the level observed in the count of the previous benchmark, as long as this was not less than 5,000. As mentioned, we endorse here the common assumption that the urban population was engaged entirely in non-agricultural activity. The difficulty lies in how to carry out the partition of the rural population into these two categories. For 1500, we accept that in Portugal, like in most of the rest of rural Europe up to the early-sixteenth century, agriculture occupied some 80 percent of the population, with the remaining 20 percent corresponding to non-agricultural occupations (Wrigley 1985, Allen 2000). At the other end of the continuum, we have reliable data from Reis (2005) for 1800 and 1850, and, for 1750, from Sá (2005). For 1700, we use unpublished material concerning personal tax rolls from various regions. We derive the remaining benchmarks – 1550, 1600 and 1650 – from the shares employed by Álvarez-Nogal and Prados de la Escosura (2007) for Spain in the same years.[25] The results are displayed in Figure 2.

[22] Notice that this year is prior to the outset of major structural changes in Portugal; see Lains (2003).
[23] For Spain, the value is 0.66, and for Italy and Germany it is 0.81, plausibly suggesting a higher level of economic development in the last two countries.
[24] Here we focus on the main procedures and results. Details are given in the online Appendix.
[25] For information about the population's distribution among these categories, see the online Appendix.

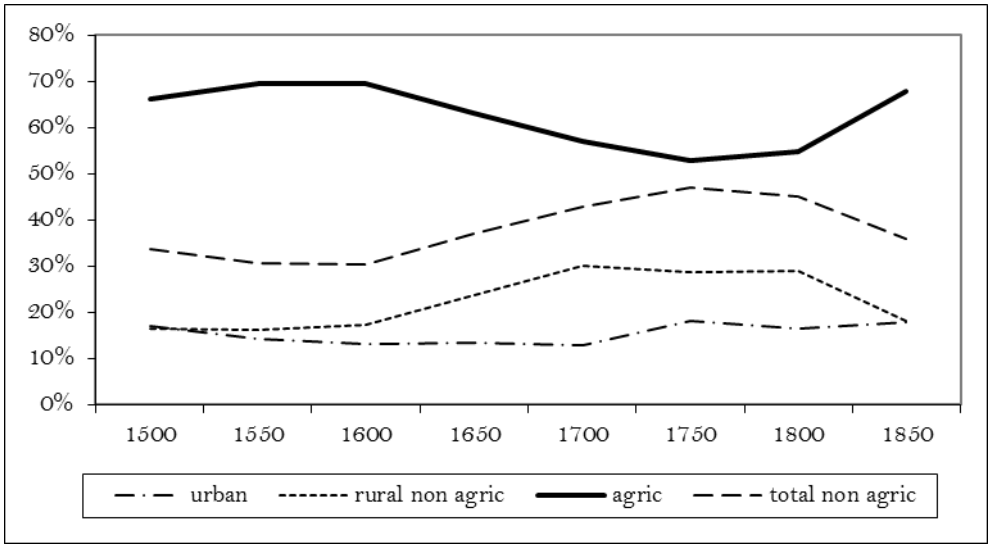

Figure 2. Occupational shares over time (50-year benchmarks). Sources: Bairoch (1988), Álvarez-Nogal and Prados dela Escosura (2007); Castro Marim and Tavira-Cacela's archival data; Sá (2005) and Reis (2005). See text and the online Appendix for further details.

2.3.5. Sectoral total factor productivity

With regard to total factor productivity in agriculture, lack of suitable data precludes our obtaining an index by the direct method. Instead, we use the "dual" approach (Antràs and Voth 2003). Input prices are represented by the weighted geometric mean of unskilled wages and rents, using the weights - respectively 65 and 35% -- employed for early modern Spain by Rosés et al. (2007). Output prices are given by the CPI for agriculture. The result of dividing the former by the latter is shown in Figure 3, alongside an HP-filtered trend component estimate, using a smoothing parameter of 6.25, as recommended for annual data by Ravn and Uhlig (2002).

Analogous difficulties are met in the case of manufacturing. We continue to make use of the "dual" approach but given even greater data restrictions, we adopt as the basis of the calculation a single manufacture, a cheap (and therefore not imported) variety of linen cloth, one of the principal textiles produced during the period in Portugal. The sectoral TFP index is obtained by calculating the simple geometric mean of the price of the raw material (flax) and the skilled wage rate, and dividing this by a cloth price series. The raw and filtered results are displayed in Figures 3 and 4.

3. Discussion

Thanks to a high land-labor ratio with roots in the Reconquista and the Black Death, around 1500 Portugal was able to provide its population with a comparatively generous living standard. Over the following three and a half centuries, however, this level of material well-being fell by almost twenty percent. This arose from a combination of extended phases of intensive growth (1550-1660; 1700-1750) with similarly lengthy periods of reversal or merely extensive growth (1500-1550; 1660-1700; 1750-1850). At the same time, this evidence reveals significant signs that this economy was far from dormant. To account for this pattern, we study here the forces which propelled it during such remarkably long positive intervals and why it was that these drivers eventually lost their momentum.

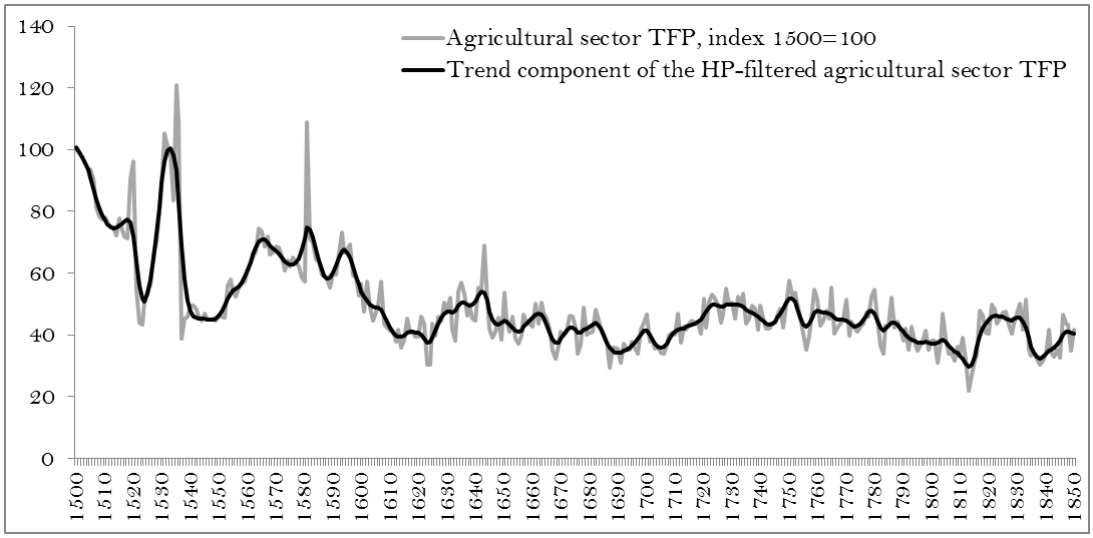

Figure 3. Agricultural total factor productivity, 1500-1850. Sources: see text and Reis (2016)

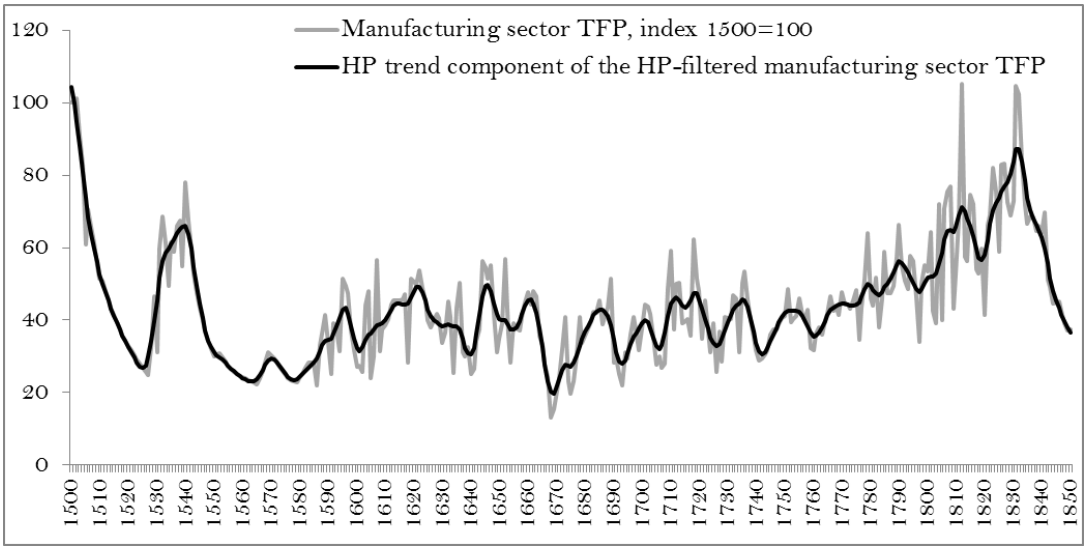

Figure 4. Manufacturing total factor productivity, 1500-1850. Sources: see text.

3.1. A stagnant economy?

The notion of persistent Early Modern stagnation is related to that of the structural inability of these economies to generate technical and organizational change on an appreciable scale. In order that some growth should happen at the intensive margin, three conditions needed to be met. One was that innovation would occur and influence sizable sectors of the economy. Another is that it would have to translate into palpable productivity gains. The third is that this impetus would have to be sustained over a relevant time span. Recent research on pre-industrial Britain and Holland demonstrates that they possessed these attributes and thus contradict the view of Malthusian historians. The relative dynamism of Portugal's performance over two centuries suggests that it may have been yet another country which did not fit the condition of economic torpor depicted by the standard literature.

As Figure 1 documents, the sixteenth century did not witness any overall progress. But in the following century and a half, a completely different picture is visible. Three forces were

mainly responsible for changing this country's economy and instilling it with a clear impulse to grow. One was the spread from around sixteen hundred of a new irrigated, highly productive crop – Indian or American maize - which displaced traditional foodstuffs and established entirely new production and consumption patterns. Another was the development, from the late-seventeenth century, of a highly commercialized and competitive Port wine sector which established a remarkable export vocation focused on the flourishing British market. The third was the establishment throughout the whole of the early modern period of an overseas empire, which linked the mother country, through a complex web of sea lanes and mercantilist ties, to a multiplicity of profitable settlements and trading posts (Costa, Palma and Reis 2015).[26] All of them were gradual developments which invoked a capacity for technical and organizational change, as well as for major investment in human, physical and financial capital. All of them had significant long-run macroeconomic implications.[27]

3.2. Portugal and the canonical Malthusian analysis

The canonical Malthusian model suggests that in premodern economies incomes always converge to a zero per capita growth steady state (e.g. Galor 2005, Clark 2007). A quick glance at GDP per capita or the real wage (Figure 1) shows that in Portugal over the *very long run*, the evidence appears to be consistent with (i.e. observationally equivalent to) this basic prediction of the Malthusian model. After about three hundred years, income did converge to a stagnant, "subsistence" level. Two issues prevent an immediate acceptance of the Malthusian picture, however. First, the simple observation of stagnation in itself does not prove whether the mechanism pulling income back to a steady state, following a short run deviation, is the equilibrium (both agricultural and labor) market response to Malthusian positive and preventive checks on mortality and fertility.[28] Second, as observed in the introduction, there was indeed at least a long period of significant deviation from the predictions of the standard Malthusian model.

In order to dig deeper into the determinants of the long run evolution of income, we need to take a look at co-variation with a host of other factors, in addition to population alone. In some models, the land-labor ratio and the productivity of the agricultural sector prices are used as exogenous variables in modelling income (O'Rourke and Williamson 2005, Rosés et al 2007). Even when explicitly recognizing that the endogenous fertility decisions of families mean there is a (lagged) negative feedback between income and the land-labor ratio, no single model or identification strategy is accepted in the literature as the best way to test the adequacy of the Malthusian model to any given period or region. Crafts and Mills (2009), Nicolini (2007), Klemp (2011) and Chiarini (2010) have all used different models and identification assumptions.

In our approach, we estimate parameters which represent reduced-form statistical associations, but we do not attribute a causal interpretation to the results. The exercise is nevertheless meaningful because it allows us to account simply for the periods in which some of the predictions of the 'classic' Malthusian model applies. We use the model of O'Rourke and Williamson (2005) and Rosés et al (2007), but we make the following changes. First, we use GDP per capita, rather than real wages, as the dependent variable.[29] Second, we allow for the possibility of autocorrelation and other non-spherical disturbances by using the Newey-West esti-

[26] In the online Appendix, we present an extended discussion of Portuguese agriculture during this period, and we also present a review of the recent empire literature.
[27] For an up-to-date overview of this period's economic history, see Costa et al (2016).
[28] It is, a priori, possible that the forces at work are of a separate institutional or political type.
[29] All data (in natural logs) have been tested for stationarity and structural breaks, which can be rejected at the usual levels of significance. Details are given in the online Appendix.

mator.[30] Finally, given the likely possibility that during the eighteenth century real per capita gold imports significantly affected incomes, we include them as a control (Morineau 1985). We start in 1530 because this is the date from which we have variation in population at the annual level (Palma and Reis 2015).

The results are shown in Table 2. Most signs, magnitudes, and significance levels come out as expected, though at first sight the sign of the marginal effect of the land-population ratio seems odd; for the full sample, a 10% increase in the land-population ratio is associated with an approximate 2% decline in the per capita GDP, all else constant, an effect which is statistically significant (Column 1). We can see, however, by comparing columns (3) and (4) with columns (5) and (6), that this effect is a result of the forces of the 1530-1755 period.[31] So what is clear from this exercise is that during the period of two hundred years from the mid-sixteenth century economic growth was sufficient to keep the economy rising in per capita terms, despite contemporaneous population growth over much of the same period.[32] Hence, the Portuguese economy cannot, over this period, be characterized as Malthusian. At the same time, the period after 1755 does roughly correspond to a situation observationally equivalent to the predictions of a canonical Malthusian model.

[30] Standard errors are Newey-West corrected. Details are given in the online Appendix.

[31] In fact, after the mid-eighteenth century the expected conditional sign does turn up – but even for this period, it is only significant as long as the year trend is not included: compare columns (5) and (6). This could be because of the smaller sample size for this period (95 observations only), or the actual absence of a conditional statistical relationship for this period, or to the problems of identification which the next paragraphs address.

[32] Growing incomes contributed themselves to this demographic outcome, both in the form of positive checks (less people died) and preventive ones (as families adjusted their fertility levels to the new income, more people were born, i.e. they could afford to have more children in a context where the latter were "normal goods").

Dependent variable: Ln of pcGDP	(1)	(2)	(3)	(4)	(5)	(6)
Estimator	OLS	OLS	OLS	OLS	OLS	OLS
Period	Full sample	Full sample	1530-1755	1530-1755	1756-1850	1756-1850
Constant	2.168*** (.6667)	1.284*** (.281)	2.531*** (.3483)	1.099*** (1.015)	1.161*** (.3055)	1.054 (3.711)
Ln of land-population ratio	-.1917*** (.0684)	-.1029*** (.0250)	-.2899*** (.0545)	-.1697* (.0963)	.1531*** (.0576)	.1608 (.2688)
Ln of Agricultural TFP	.0656*** (.0189)	-	.1100*** (.0251)	1166*** (.0234)	.1027*** (.0256)	.1030*** (.0307)
Ln of Manufacturing TFP	-.0306*** (.0108)	-.033*** (.0102)	-.0143 (.0147)	-.010 (.0139)	-.0252* (.0149)	-.0254* (.0138)
Linear time trend	-.0002 (.0002)	-	-	.0005 .0004	-	.00004 (.0013)
Ln of gold imports from Brazil (at constant prices)	.0021** (.0008)	.0028** (.0011)	-.0023 (.0018)	-.004 (.0023)	-.0005 (.0022)	-.0005 (.0025)
Ln of per capita GDP (t-1)	.7909*** (.0412)	-	.6452*** (.0629)	.6293*** (.065)	.5983*** (.0781)	.5996*** (.0887)
R^2 or pseudo R^2	0.8888	0.8882	0.8939	0.8951	0.8388	0.8388
Number of observations	320	320	225	225	95	95

Table 2. Explaining Portuguese per capita GDP 1530-1850. In columns (1)-(4) the Newey-West HAC standard errors allow autocorrelation up to 5 lags. ***=individually statistically significant at the 1% level, **= at 5% level, *= at 10% level.

3.3. An early modern little divergence?

Portugal's economy is held to have been comparatively backward during the early modern period (Allen 2005, van Zanden 2009). By contrast, we have shown that the Portuguese economy experienced two centuries of per capita growth between 1550 and 1755: 0.37% a year.[33] Portugal's rate hence compares favorably with that of the Netherlands 0.41% per year during 1500-1650 and that for England/Britain, of 0.33% for 1600-1750, their respective golden ages of early modern growth.

We now shift the discussion from volume-based measures to a comparison of income levels. There are two alternative benchmarks from which past income levels can be calculated. The standard option (Table 3) is to use Geary-Khamis 1990 international dollars (henceforth referred to as the GK method)[34], while the alternative is the indirect method of Prados de la Escosura (2000).

	England/GB	Holland	Germany	France	North and Central Italy	Spain	Sweden	Portugal (Maddison 2003)	Portugal (this study)
1500	1068	1454	1146	-	1553	846	-	606	1134
1550	1058	1798	-	-	-	-	995 (y.1560)	-	578
1600	1082	2662	806	-	1363	892	761	740	933
1650	925	2691	948	-	1398	687	966	-	1059
1700	1513	2105	939	-	1476	814	1340	819	898
1750	1695	2355	1050	-	1533	783	973	-	1216
1800	2097	2609	986	-	1363	916	857	923 (y. 1820)	1002
1850	2330	2355	1428	1597	1481	1079	1076	923	923

Table 3. Output per capita in Europe in "international" GK dollars of 1990, extrapolating backwards from the 1850 benchmark in Maddison (2003). Data sources for the growth rates: For England/GB, Broadberry et al (2015); for Holland, van Zanden and van Leuween (2012); for Germany, Pfister (2011); for France, Álvarez-Nogal and Prados de la Escosura (2013, p. 23); for North and Central Italy, Malanima (2011); for Spain, Álvarez-Nogal and Prados de la Escosura (2013); for Sweden, Schön and Krantz (2012). Note that the geographic boundaries for three of the 1850 benchmarks – GB, Netherlands, and Italy – do not precisely match those of the growth rates.

While standard, the GK method has the disadvantage of relying on more remote PPPs than those used by Prados de la Escosura. Consequently, the well-known index number problems associated with this kind of exercise (Deaton and Heston 2010, Allen 2013) will be more strongly felt when using the former method. This is especially true when taking into consideration the fact that the nineteenth century was a period of fast structural change and relative price movements for many European countries. For this reason, it is worthwhile to also show the results of the latter method. These are in Table 4.[35] One outcome may be surprising to some: in 1750, Portugal's per capita GDP was higher than that of France, Spain, Germany and Sweden and at around the same level as Great Britain and the Netherlands. Portugal was only poorer than Italy.

[33] This annualized growth rate was calculated using the familiar compound growth formula.
[34] In the online Appendix, we also compare our new GK figures for Portugal with those for other countries according to Maddison (2010).
[35] See Fouquet and Broadberry (2015, p. 230) for a graph using the GK method.

	England/GB	Holland	Germany	France	North and Central Italy	Spain	Sweden	Portugal
1500	39	37	49	50	68	50	-	58
1550	39	37	-	-	64	54	35	30
1600	37	68	34	50	60	53	36	44
1650	34	69	-	-	62	41	-	51
1700	55	54	40	54	65	48	53	45
1750	61	60	45	55	68	46	41	59
1800	75	67	42	56	60	54	40	50
1850	100	79	61	78	66	64	52	46

Table 4. Output per capita in Europe (GB 1850=100), using the method of Prados de la Escosura (2000, p. 24). Italy's 1860 level was assumed to be that of 1850, following Álvarez-Nogal and Prados de la Escosura (2013, p. 23). Data sources: the same as in Table 3.

Portugal's favorable circumstances by the mid-eighteenth century, which were largely the result of remarkable growth in the previous half century (but also dated back to the sixteen hundreds) were not to last, however. In the very long run, the economy conformed to the predictions of the Malthusian model. Despite variation in response to shocks, income converted back to what could be interpreted as a long-term "subsistence" level. Nonetheless, while the forces of convergence to such a steady state did include endogenous fertility and mortality responses in the spirit of Malthus, it is equally possible that negative effects of a political economy or institutional nature were also present.

3.4. The great reversal (1750s-1850)

The evolution of the Portuguese economy during 1500-1850 is neither a story of regression, nor one of a monotonic decline. If anything and only if viewed over the *very* long run, it is one of stagnation. It is best described perhaps as a set of two long spells of growth (1550s-1650s and 1700-1750s) followed, after 1750, by a century representing a great reversal in both absolute and comparative terms (Figure 1 and Tables 3 and 4).

The 1750-1850 setback is of interest for three reasons. One is that it caused a considerable and sustained erosion of living standards at a cumulative rate of 0.26 per cent annually. The second is that such an inversion presupposes the occurrence of significant changes in the dynamic elements that caused the country's upswing during the preceding half-century. They obviously need to be analyzed as corroboration for our hypotheses concerning earlier surges. The third is that their study can contribute to furthering an emerging shift in research on long term pre-industrial growth. As Broadberry (2016, p. 13) has put it recently, 'one way to think about Europe's Little Divergence, and also the Great Divergence, is therefore not so much the beginnings of growth but rather the weakening and ending of growth reversals'.

What explains Portugal's great reversal from the 1750s?[36] A central aspect is clearly the exhaustion of the three dynamic forces for growth of the preceding surge, which now ceased to generate sustained positive macroeconomic effects. Innovation had brought them into existence but could not ensure their continuing success in the face of exogenously imposed adversity. In the case of maize, a natural resource barrier stifled its progress of more than a hundred years. In that of port wine, practically one market only mattered – Britain. Yet, when the policies that regulated it became adverse to Portuguese exports, there was nothing that producers or the state could do to overcome this. Regarding the colonies and their mercantilist benefits, these could only be maintained as long as it was in Britain's interest to protect them from predator states. In 1808, this came to an end when, as a result of the convulsions of the Napoleonic wars, Portugal was forced, in order to survive, to open its ports to 'friendly nations'.

A second dimension is that population meanwhile started to grow at increasing rates, which represents a substantial alteration relative to the first half of the eighteenth century. It also brings to light the role played by low-pressure demography in achieving the economic success of the earlier sub-period (Table 5). Two causes could have been responsible for the post-1750s population upsurge. One is that it was a reaction to the relatively slow demographic expansion in 1700-1750, a period much affected by gold-rush induced migration to Brazil. The other is the high per capita income at mid-century, and its steady but only gradual erosion to levels which, nevertheless, for decades stayed above Malthusian subsistence thresholds.

	% GDP	% Population change	% GDP per capita
1700-1850	0.34	0.32	0.02
1700-1755	0.77	0.16	0.61
1755-1800	-0.19	0.31	-0.5
1800-1850	0.33	0.49	-.016

Table 5. Rates of annual change for population, GDP, and per capita GDP. Sources: see text

One proximate factor which we might have expected to become a barrier to development does not seem to play an important role. According to the weak state hypothesis, low levels of fiscal extraction lead to backwardness (Besley and Persson 2011, Dincecco and Katz 2014). While this argument carries weight in explaining the divergence between Western Europe and other parts of the world, it cannot explain the divergence within Western Europe itself. As Figure 5 and Table 6 show, the levels of fiscal capacity within the latter region were roughly similar, including for Portugal.[37] On the other hand, even at its peak, when Portugal was comparatively rich, it did not succeed in achieving high levels of structural change (Figure 2) or industrial development.[38] The long-term roots of Portugal's backwardness may lie here.[39]

[36] In this discussion, we focus on proximate aspects and leave out fundamental causes which relate to culture, institutions, economic geography, and human capital. But it is certainly true, for example, that levels of human capital were and remained low by northern European standards (Reis 2005b, p. 202).

[37] The Portuguese fiscal system was also, from an early stage, remarkably modern; a 10% income tax (*décima*) was authorized by parliament in 1641, and kept into the nineteenth century (Costa et al 2016, pp. 116-119).

[38] See the online Appendix for details about occupational change over this period, and Costa et al (2016) for a discussion of Portugal's industry over this period.

[39] Of course, lack of structural change or industrial development could be symptoms as well as causes. In the online Appendix, we present a more extended discussion of the proximate causes for Portuguese decline over the 1750-1850 period.

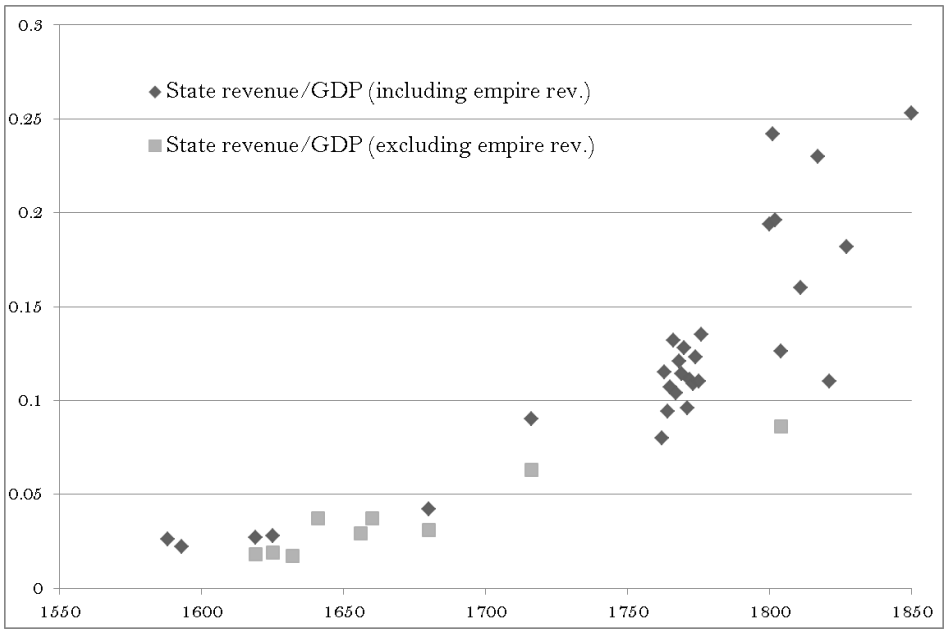

Figure 5. Ratio of state revenue in current prices to nominal GDP. Revenues from the following sources: For 1607, Falcão (1859); for 1619, Oliveira (1620); for 1625, Hespanha (1994, pp. 124-5), for 1680, Dias (1985); for 1716 and 1804, Macedo (1982, p. 209), for 1763, Tomaz (1988, pp.355-388) and for 1800, 1801, 1802, 1811, 1817, 1821,1827, Silveira, (1987, pp. 505-529).

	China	Ottoman empire	Russia	Poland-Lithuania	Austria	Prussia	France	Venice	Spain	England	Dutch Republic	Portugal
1500-1549	-	-	-	0.8	-	-	2.6	10.4	3.0	1.5	-	-
1550-1599	-	1.7	-	0.4	-	-	3.2	9.5	4.0	2.7	-	-
1600-49	-	1.4	-	0.5	-	-	3.0	7.5	7.2	2.6	12.0	7.1
1650-99	-	1.7	-	1.3	2.6	2.0	8.0	10.6	7.7	4.2	13.6	5.6
1700-49	2.3	2.6	4.4	0.6	6.3	6.6	6.7	12.7	4.6	8.9	24.1	8.0
1750-99	1.3	2.0	7.6	1.7	11.3	14.1	11.4	13.2	10.0	12.6	22.8	15.6
1800-49	1.2	5.0	6.2	-	10.2	-	14.3	-	8.6	13.5	-	9.1

Table 6. Size of Leviathan: Per capita government revenue in day's wages for urban, unskilled workers. Sources: For China, Brandt et al (2014, p. 69). For all other countries except Portugal, Karaman and Pamuk (2010), with 1500-1799 data presented in 50-year rather than 10-year intervals, following Brandt et al (2014). We have updated Russia, and also added 1800-49 values using data kindly provided by Kivanç Karaman. For Portugal: our calculation, using for 1607 Falcão (1859), for 1619 Oliveira (1620), for 1625 Hespanha (1994), for 1680 Dias (1985), for 1716 and 198, Macedo (1982) for 1763, Tomaz (1988), and for 1800, 1801, 1802, 1811, 1817, 1821,1827, Silveira (1987).

4. Conclusion

Thomas and McCloskey (1981, p.102) have described Portugal, along with Spain, as "giants" of the sixteenth century, especially in comparison with Britain, the "inconsiderable little island of the sixteenth century, a mere dwarf". In turn, Bairoch (1976) considered Portugal one of Europe's five richest countries as late as 1800, and Lisbon one of Europe's four most populous cities (after Naples, Paris and London). How do these statements stand up in comparison with the evidence we have gathered here? The discussion so far allows us to draw three conclusions:

1. During much of the early modern period Portugal was comparatively prosperous. While a loss of dynamism is already noticeable from the second half of the eighteenth century, as late as 1750 income levels in Portugal may have been as high as those in Britain and Holland, and higher than in France, Spain, Germany and Sweden.

2. At least until the mid-eighteenth century, Portugal was not Malthusian, in the sense that per capita income did not have a tendency to converge towards a stagnation steady-state. This is confirmed by the 200-year contemporary rise in per capita income and population. Much growth was of an extensive nature, but nevertheless Malthusian forces were not sufficient to cancel Smithian intensive growth opportunities (Mokyr and Voth 2008).

3. Portugal provides support for an early modern European "little divergence". The timing of this divergence varies according to the method of comparison in use and the country of reference. Compared with England/GB, such a divergence did happen over the early modern period, but it dates from either the second half of the seventeenth century (as in Table 3) or from a century later (as in Table 4).[40]

4. After the mid-eighteenth century Portugal entered a period of persistent decline which had as proximate causes the increase in population combined with the exhaustion of the previously available engines of economic growth without their substitution by new sources. Whether there was also an institutional element in this decline and how it may be related to the previous resource boom and episode of "extractive growth" (Acemoglu and Robinson 2012) remains unclear at the moment. What is certain is that the growth which had taken place until then was accompanied by limited structural change.

In the spirit of Broadberry et al (2015) or van Zanden and Leeuwen (2012), who focus on proximate rather than fundamental causes of growth, our goal in this paper has been to provide a factual description of Portugal's macroeconomic history during this period. We have offered an account of the main proximate factors of the growth and decline of Portugal's economy from the early sixteenth to the mid-nineteenth century. This enables us to add Portugal to the pool of existing evidence on GDP, as well as factor and commodity prices and allows us to round off the usual picture for early modern Europe with the inclusion of a non-core economy in this context.

Although Portugal enjoyed comparatively high incomes well into the early modern period, its structural modernization was comparatively slow. As the engines of growth ran out of steam after the 1750s, a reversal took place which, in due time, would leave Portugal as one of the poorest countries in Europe.

[40] For a similar finding but using real wages, see Malanima (2013).

References

Acemoglu, D. and J. Robinson (2012). *Why Nations Fail: The Origins of Power, Prosperity and Poverty*. New York: Profile Books.

Allen, Robert C. (2000). Economic structure and agricultural productivity in Europe, 1300-1800. *European Review of Economic History* 4: 1-25.

Allen, Robert C. (2001). The Great Divergence in European Wages and Prices from the Middle Ages to the First World War. *Explorations in Economic History*, 38, 411-447.

Allen, Robert C. (2003). Progress and Poverty in Early Modern Europe. *Economic History Review* 3, 403-443.

Allen, Robert C. (2005). Real Wages in Europe and Asia: A First Look at the Long-term Patterns. In: *Living Standards in the Past. New Perspectives on Well-Being in Asia and Europe*, eds. Allen, Robert C., Bengtsson, Tommy and Martin Dribe. Oxford: Oxford University Press.

Allen, R. (2013). Poverty Lines in History, Theory, and Current International Practice. Working paper, Department of Economics, University of Oxford

Álvarez-Nogal, Carlos and Leandro Prados de la Escosura (2007). The decline of Spain (1500-1850): Conjectural estimates. *European Review of Economic History* 11, 319-366.

Álvarez-Nogal, Carlos and Leandro Prados de la Escosura (2013). The rise and fall of Spain (1270–1850). *The Economic History Review* 66 (1): 1–37.

Álvarez-Nogal, Carlos, Prados de la Escosura, Leandro and Carlos Santiago-Caballero (2016). Spanish agriculture in the little divergence. *European Review of Economic History*. Forthcoming.

Antràs, Pol and Voth, Joachim (2003). Factor prices and productivity growth during the British industrial revolution. *Explorations in Economic History* 40, 52-77.

Bairoch, P. (1976). Europe's Gross National Product: 1800-1975. *Journal of European Economic History* **5**, 273-340.

Bairoch, P., Batou, J. and P. Chèvre (1988). *La Population des Villes Européennes, 800-1850*. Geneva: Librairie Droz.

Besley, T., and Persson, T. (2011). *Pillars of prosperity: The political economics of development clusters*. Princeton University Press.

Broadberry, S. (2016). When and why did the great divergence begin? *Unpublished manuscript*

Broadberry, S., Campbell, B., Klein, A., Overton, M. and B. van Leeuwen (2015). *British Economic Growth 1270-1870*. Cambridge: Cambridge University Press.

Chiarini, Bruno, (2010). Was Malthus right? The relationship between population and real wages in Italian history, 1320 to 1870. *Explorations in Economic History* 4, 460-475.

Costa, L., Lains, P. and S. Miranda (2016). *An Economic History of Portugal, 1143-2010.* Cambridge: Cambridge University Press.

Costa, Leonor, Palma, Nuno and Jaime Reis (2015). The great escape? The contribution of the Empire to Portugal's economic growth, 1500-1800. *European Review of Economic History* 19, 1-22.

Costa, Leonor and Jaime Reis (2016). The chronic food deficit of early modern Portugal: Curse or myth? Working Papers of GHES, No 2016/58.

Clark, Gregory (2007). *A Farewell to Alms. A Brief Economic History of the World.* Princeton University Press.

Clark, G. (2010). The macroeconomic aggregates for England, 1209-2008. Research in Economic History, 27(1), 51-140.

Crafts, Nicholas and Mills, Terence (2009). From Malthus to Solow: how did the Malthusian economy really evolve? *Journal of Macroeconomics* **31**, 68-93.

Deaton, A. and A. Heston (2010). Understanding PPPs and PPP-based National Accounts. *American Economic Journal: Macroeconomics* **2**, 1-35.

Dincecco, M., and Katz, G. (2014). State Capacity and Long-run Economic Performance. *The Economic Journal* 126, pp. 189-218.

Edvinsson, Rodney (2013a). New annual estimates of Swedish GDP, 1800–2010, *Economic History Review*, **66**, 1101-1126.

Edvinsson, Rodney (2013b). Swedish GDP 1620-1800: stagnation or growth?, *Cliometrica*, **7**, 37-60.

Falcão, Figueiredo (1859). *Livro em que se Contem toda a Fazenda e Real Património dos Reinos de Portugal, India e Ilhas Adjacentes* (Lisboa: Imprensa Nacional).

Fonseca, Helder Adegar (1996). *O Alentejo no Século XIX: Economia e Atitudes Económicas.* Lisboa: Imprensa Nacional – Casa da Moeda.

Fonseca, Helder and Jaime Reis (2011). The limits of agricultural growth in a fragile eco-system: Total factor productivity in Alentejo, 1750-1850. In: Olsson, M. and P. Svensson (eds.) *Growth and Stagnation in European Historical Agriculture.* Turnhout: Brepols, 37-66.

Fouquet, R., and Broadberry, S. (2015). Seven centuries of European economic growth and decline. *Journal of Economic Perspectives*, 29 (4).

Galor, O. (2005). From stagnation to growth: Unified growth theory. In: Philippe Aghion and Steven N. Durlauf Eds). *Handbook of Economic Growth.* Amsterdam: Elsevier **1**, 171-293.

Godinho, Vitorino Magalhães (1968-1972). *Ensaios*. Lisboa: Sá da Costa, 4 vols.

Grafe, R. (2015). Economic and Social Trends. In: *The Oxford Handbook of Early Modern European History, 1350-1750: Volume I: Peoples and Places*. Ed. Hamish Scott. Oxford: Oxford University Press, 269-294.

Hespanha, António (1994) *As Vésperas do Leviathan. Instituições e Poder Político: Portugal - Séc.XVII*. Coimbra: Almedina.

Klemp, Marcus (2011). Prices, wages and fertility in pre-industrial England. *Cliometrica* 6, 63-77.

Lains, Pedro (2003). New wine in old bottles: Output and productivity trends in Portuguese agriculture, 1850-1950". *European Review of Economic History* **7**, 43-72.

Macedo, J. Borges (1982). *Problemas da História da Indústria Portuguesa no Século XVIII*. Lisboa: Querco.

Maddison, Angus (2003). *The World Economy: Historical Statistics*. OECD

Maddison, Angus (2010). Statistics on world population, GDP and per capita GDP, 1-2008 AD. Groningen Growth and Development Centre. Accessed 9 of September 2016 from: http://www.ggdc.net/maddison/oriindex.htm

Malanima, Paolo (2011). The long decline of a leading economy: GDP in central and northern Italy, 1300-1913. *European Review of Economic History* **15**, 169-219.

Malanima, Paolo (2013). When did England overtake Italy? Medieval and early modern divergence in prices and wages. *European Review of Economic History* **1,** 45-70.

Mokyr, Joel and Hans-Joachim Voth (2008). Understanding growth in Europe, 1700-1870: Theory and evidence. In: Stephen Broadberry and Kevin H. O'Rourke (eds). *The Cambridge Economic History of Modern Europe*. Cambridge: Cambridge University Press. Vol. 1, 7-42.

Monteiro, Nuno (2005). A ocupação da terra. In Lains, Pedro and Álvaro Silva (eds). *História Económica de Portugal* (Lisboa: ICS), vol. I, 67-92.

Morineau, M. (1985). *Incroyables Gazettes et Fabuleux Métaux: Les Retours des Trèsors Américains d'Après les Gazettes Hollandaises (XVI-XVII Siècles)*. Cambridge: Cambridge University Press.

Nicolini, E. (2007). Was Malthus right? A VAR analysis of economic and demographic interactions in pre-industrial England. *European Review of Economic History* **11**, 99-121

O'Rourke, Kevin H. and Williamson, Jeffrey G. (2005). From Malthus to Ohlin: Trade, industrialisation and distribution since 1500. *Journal of Economic Growth* **10**, 5-34.

Oliveira, João (1990). *A Produção Agrícola de Viseu entre 1550 e 1700*. Viseu: Câmara Municipal de Viseu.

Oliveira, João (2002). *A Beira Alta de 1700 a 1840. Gentes e Subsistências*. Viseu: Palimage.

Oliveira, Nicolau (1620). *Tratado das Grandezas de Lisboa.* Lisboa: Jorge Rodriguez.

Palma, Nuno and Jaime Reis (2015). Reconstruction of regional and national population estimates using intermittent census-type data: the case of Portugal, 1527-1864. *Unpublished manuscript.*

Pfister, Ulrich (2011). Economic growth in Germany, 1500–1850. Unpublished manuscript. Presented at the "Quantifying long run economic development" conference, University of Warwick in Venice.

Pfister, Ulrich, Riedel, Jana and Martin Uebele (2012). Real wages and the origins of modern economic growth in Germany, 16th to 19th centuries. EHES Working Papers in Economic History, Nº 17.

Prados de la Escosura, Leandro (2000). International comparisons of real product, 1820-1990: An alternative data set. *Explorations in Economic History* **37**, 1-41.

Ravn, Morten and Harald Uhlig, (2002). On adjusting the Hodrick–Prescott filter for the frequency of observations. *The Review of Economics and Statistics* **84**, 371–375.

Reis, Jaime (2000). How poor was the European periphery before 1850? The Mediterranean vs. Scandinavia. In: *The Mediterranean response to Globalization before 1950*, eds S. Pamuk and J. Williamson. London: Routledge, 17-44.

Reis, Jaime (2005a). O trabalho. In Silva, Álvaro da and Pedro Lains (eds.*) História de Portugal.* Lisboa: ICS, vol. 2, 119-151.

Reis, Jaime (2005b). Economic growth, human capital formation and consumption in western Europe before 1800. In: In: *Living Standards in the Past. New Perspectives on Well-Being in Asia and Europe*, eds. Allen, Robert, Bengtsson, Tommy and Martin Dribe. Oxford: Oxford University Press, 195-225.

Reis, Jaime (2016). Gross agricultural output: a quantitative, unified perspective, 1500-1850. In: *An Agrarian History of Portugal, 1000-2000. Economic development on the European frontier*, eds, Dulce Freire and Pedro Lains. Leiden: Brill, pp. 166-196.

Rosés, Joan, O'Rourke, Kevin and Jeffrey Williamson (2007). Globalization, growth and distribution in Spain 1500-1913. Working Papers in Economic History, Departamento de Historia Económica e Instituciones, Universidad Carlos III de Madrid, WP-08.

Sá, Isabel (2005). O trabalho. In: Lains, Pedro and Silva, Álvaro (eds), *História Económica de Portugal 1700-2000. O Século XVIII.* Lisboa: ICS, vol. I, 93-121.

Santos, Rui (2003). *Sociogénese do Latifundismo Moderno: Mercados, Crises e Mudança Social na Região de Évora, Séculos XVII a XIX.* Lisboa: Banco de Portugal.

Schön, Lennart and Olle Krantz (2012). The Swedish economy in the early modern period: constructing historical national accounts. *European Review of Economic History* **16**, 529-549.

Silveira, Luís (1987). Aspectos da evolução das finanças públicas portuguesas (1800-1827). *Análise Social* **23**, 505- 29.

Thomas, Richard and McCloskey, Deirdre (1981). Overseas trade and empire 1700-1800. In Roderick Floud and Deirdre McCloskey (eds), *The Economic History of Britain since 1700.* Cambridge: Cambridge University Press, vol. 1, 87-102.

Tomaz, Fernando (1988). As finanças do estado pombalino1762-1776. In: *Estudos e Ensaios em Homenagem a Vitorino Magalhães Godinho.* Lisboa: Sá da Costa, 355-388.

Van Zanden, J. L. (2009). *The Long Road to the Industrial Revolution: The European Economy in a Global Perspective, 1000-1800.* Leiden: Brill.

Van Zanden, Jan Luiten and Bas van Leeuwen (2012). Persistent but not consistent: The growth of national income in Holland 1347-1807. *Explorations in Economic History* **49**, 119-130.

Wrigley, E. A. (1985). Urban growth and agricultural change: England and the Continent in the early modern period. *Journal of Interdisciplinary History* **15**, 683-728.

Wrigley, E. A. and R. S. Schofield (2010/1989). *The Population History of England 1541-1871.* Cambridge: Cambridge University Press. New edition.

Wrigley, E. A., Davies, R. S., Oeppen, J. E. and R. S. Schofield (1997). *English Population History from Family Reconstitution 1580-1837.* Cambridge: Cambridge University Press.

Appendix to

FROM CONVERGENCE TO DIVERGENCE: PORTUGUESE DEMOGRAPHY AND ECONOMIC GROWTH, 1500-1850

(FOR ONLINE PUBLICATION ONLY)

The data for this paper is available online at: [link to be added]

I – Brief details about the demographic reconstruction

The population stock in certain periods is known approximately from counts (*numeramentos*), available for 1527-31, 1706, 1758. They are also available from the 1801, 1841 and 1864 censuses. Palma and Reis (2015) combine these with a large sample of parish records which provides annual information on births and deaths. Together with some additional assumptions, this allows for the reconstruction of population at the annual level.

II - Percentage of the yearly variation of the principal data that is covered by our sources

	Unskilled wages	Skilled wages	Wheat bread	Maize bread	Meat	Eggs	Chickens	Wine	Olive oil	Coal	Linen	Population
16th c.	54	47	66	n.a.	40	33	56	48	49	52	32	70
17th c.	40	42	92	84	98	100	100	83	100	98	60	100
18th c.	65	79	96	94	99	100	100	100	100	80	83	100
1801-1850	100	98	100	100	100	100	100	78	100	26	100	100

Table A1. Data coverage for the main variables underlying the construction of our series (%). Sources: PWR project; Reis (2016) for calculations; for population, Palma and Reis (2015).

III - Portugal's external food balance

Table A2 shows the results of the estimations used. The Appendix to Costa and Reis (2016) gives the information on sources and how these figures were arrived. For each benchmark, the export or import of the three main items of food trade, in their respective current values in grams of silver (cols.1, 2 and 3) is expressed and then summed up to obtain the overall food deficit or surplus in silver too (col.4). Since we do not possess any quantification of national agricultural consumption at current prices, a short cut estimation method proposed by Malanima (2011, p. 179) is used instead. This procedure starts by multiplying the total wage bill in grams of silver by 1.4 which gives us the estimated income of all production factors (land, labor and capital). This is multiplied by a coefficient of 0.6, to arrive at a figure, also in silver, representing the total expenditure on food by the recipients of national income, i.e. the population (col.5). We can then determine the magnitude of the food surplus/deficit relative to food consumption (col 6 of table A2) and the value of the ratio **r** (col. 7 of table A2) which can be used to adjust correctly food consumption when trying to estimate agricultural output.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Wine exports	Olive oil exports	Grain imports	Food surplus/deficit	Agricultural consumption	Surplus/deficit /agricultural consumption %	Food production/ consumption ratio **r**
1550	-	0.7	17.4	-16.7	916.1	-1.82	0.982
1600	0.02	14.2	24.5	-10.3	1965	-0.005	0.995
1650	0.9	18.5	14.3	5.1	1961	0.003	1.003
1700	11.9	27.2	14.4	24.7	1858	1.3	1.013
1750	14.9	15.6*	23.0	7.5	2311	0.3	1.003
1800	128.5	8.3	151.6	-14.8	3360	-0.4	0.996
1850	117.2	4.3	6.95	114.6	3742	3.1	1.031

Table A2. Portugal's external food balance. Cols 1-5 in millions of grams of silver. * interpolated value based on average of quantities for 1700 and 1800 valued at 1750 prices. Source: Costa and Reis (2016)

IV - Inter-sectoral productivity

The underlying assumption of time-invariance for p (within our period) warrants further discussion. In our baseline estimate, we employed a constant value of 0.7 for p. We now consider a robustness check where we transform this parameter into a variable. In order to proceed, we alter the way in which the inter-sectoral productivity gap is defined. Instead of making it the ratio of the productivities of agriculture and the whole economy (as in Crafts 1984), we set as p the ratio of the productivities of the agricultural and the non-agricultural sectors (as in Pfister 2011). This is a change in definition which makes no difference as far as the underlying data is concerned, but enables us to introduce a realistic method for adjusting the value of p over time to the shifts in sector-specific productivity. Specifically, we allow p to vary with the ratio of the TFPs, respectively, of agriculture and industry. This is not ideal given that, besides manufacturing, the non-agricultural sector also comprises trade and other services, for which we have no efficiency measure. It is a second best solution but allows us to gauge the impact on the final result of changing the initial assumption about the constancy of p. As explained in the text, the expression for obtaining the initial p, for the year 1850, is

$$p_{1850} = \frac{Q_{a,1850}/Q_{na,1850}}{L_{a,1850}/L_{na,1850}}$$

in which $Q_{a,1850}$ is agricultural output, $Q_{na,1850}$ is non-agricultural output and $L_{a,1850}$ and $L_{na,1850}$ are, respectively, the total labor of these two sectors. Notice that the change in the way in which p is here conceptualized means that its value for the mid-nineteenth century benchmark is different from what would come out using the Crafts' definition (1984, p. 446). This compares the productivity of agriculture with that of the economy overall, rather than with that of non-agriculture as we do here, following Pfister (2011, p. 8). Despite the slight change in interpretation the two definitions are closely related and equivalent as far as the demands on data are concerned.

V - Robustness checks: endogenous labor supply and variable inter-sectoral productivity

We now show the GDP figure with and without endogenous labor supply (see Figure A1).

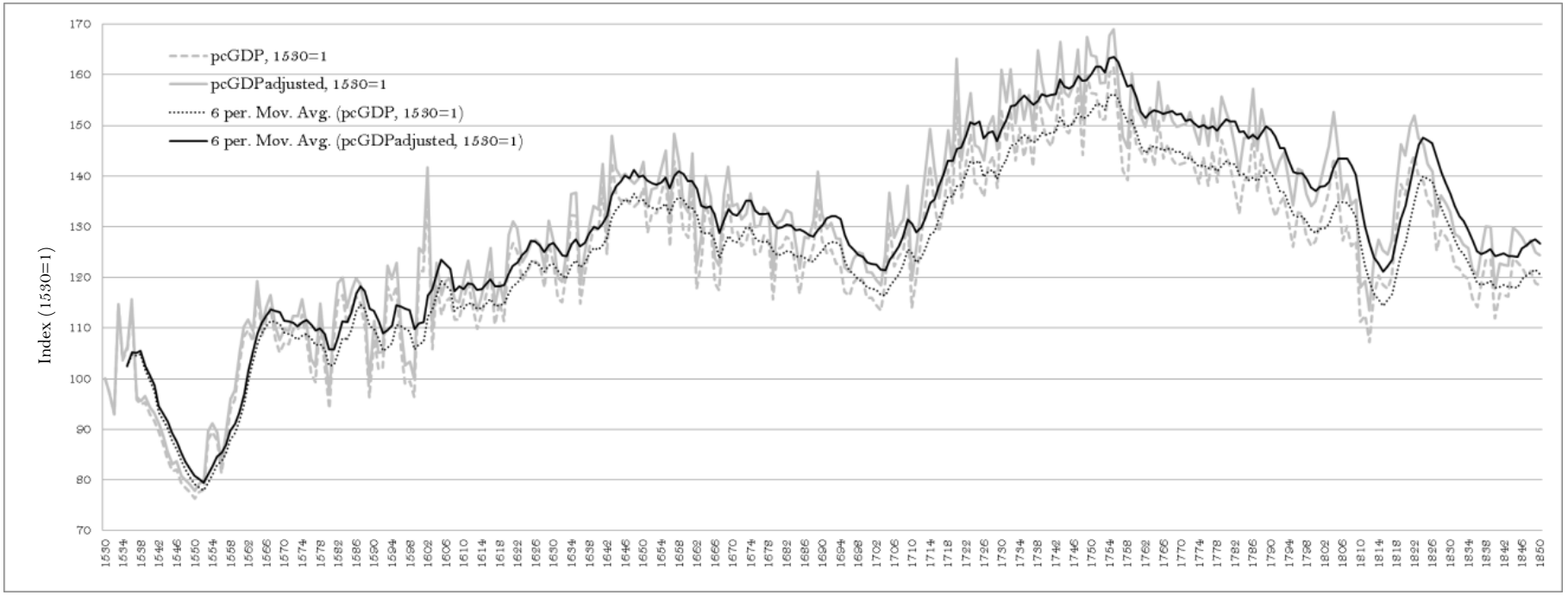

Figure A1. GDP per capita, adjusted vs. unadjusted for endogenous changes in labor supply. The black line corresponds to a MA(6) of the baseline estimates from the main text, while the intermittent black line corresponds to a MA(6) of the series calculated under the assumption of constant labor supply. Source: see text.

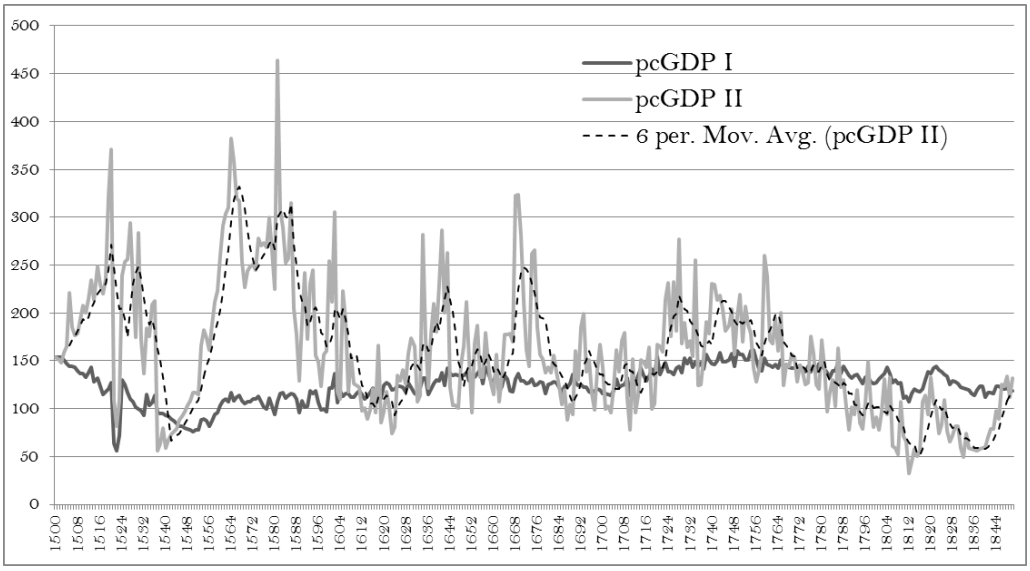

Figure A2. Portugal's GDP per capita with fixed or variable p.

As a robustness check for the effects of relaxing the assumption of time-invariance, we now modify our calculation of non-agricultural GDP using an alternative measure for p, allowing it to vary in time. Under this procedure, $p(t)$ is a function. Its value for each year t is obtained by multiplying the initial 1850 figure by the ratio of the TFPs of agriculture and manufacturing corresponding to each year. In Figure A1 we show the results with p fixed (pcGDP I) or variable (pcGDP II). As the figure suggests, allowing p to vary with the ratio of TFPs seems to induce a good measure of (probably spurious) volatility, but the trends are not different from our baseline procedure.

VI – Additional international comparisons

	UK	Netherlands	Germany	France	Italy	Spain	Sweden	Portugal (Maddison)	Portugal (this study)
1500	714	761	688	727	1100	661	651	606	1134
1550	-	-	-	-	-	-	-	-	578
1600	974	1381	791	841	1100	853	700	740	933
1650	-	-	-	-	-	-	-	-	1059
1700	1250	2130	910	910	1100	853	750	819	898
1750	-	-	-	-	-	-	-	-	1216
1820	1706	1838	1077	1135	1117	1008	819	923	1002
1830	1749	2013	1320	1191	-	-	870	-	986
1840	1990	2283	-	1428	-	-	-	-	874
1850	2330	2371	1428	1597	1350	1079	1019	923	923

Table A3. Output per capita in Europe in "international" GK dollars of 1990. Every column except the last from Maddison (2010). Note that Maddison did not change Portugal's 1850 benchmark between the publication of Maddison (2003) and Maddison (2010).

VII – Economic progress in early modern Portugal: A brief guide

Thanks to a high land-labor ratio with roots in the Reconquista and the Black Death, around 1500 the Portuguese economy was capable of providing the population with a comparatively generous standard of living. The productive specialization of agriculture was that of Southern Europe, with animal husbandry as the largest sub-sector, followed closely by grain and, a long way behind, by wine and olive oil (Henriques and Reis 2016). During the next one hundred years, population doubled and yet the agrarian system remained in essence technically immobile. The most important response of the economy to this challenge was the classical one of the middle ages (Barata and Henriques 2011): to push back the tillage frontier by clearing bush lands, forest land and rough pastures. On these new spaces, the traditional methods and products were replicated, this time with increasing labor inputs per hectare as might be expected given the steady decline of the land-labor ratio.

Not a great deal is known about sixteenth century land clearances (*arroteias*) in terms of their scale, geography and timing. They corresponded to quality improvements on lands which were already under some form of usage. They spread considerably throughout the country, though more in the Beira and Estremadura regions than elsewhere (Miranda 2016). It also seems to have been a fairly vigorous process, as attested by the continuously mounting rent-wage ratio shown in Figure A3. This reflected the growing scarcity of land relative to labor and the resultant upward pressure over the entire century to extend and invest in the arable sector. Meanwhile, as more and more land went under the plough, a decline in its quality at the margin seems probable. This and the rise of the labor-to-land ratio will have contributed to the pronounced downward trend in agricultural productivity (see Figure 3 of the main text) which was characteristic of most of this period. Finally, the persistent shift in relative factor scarcity from labor to land appears to have led to a movement from land to labor-intensive production which could did not pass unnoticed. In 1553, the count of Castanheira wrote in a summary to the king: 'much bush has been cleared and more land ploughed than ever before … but so has the cost of producing grain … and livestock has not increased as much'.[41]

Throughout the next two centuries, however, there seems to have been a decline in the amount of under-utilized land available for putting under the plough. Data from the accounts of several monasteries suggest that new leases for clearing land were becoming less common, with a clear drop from the early-seventeenth century onward. (Oliveira 1979, Maia 1991, Neto 1997, Campos 1989, Silva 1994, Amorim 1994). After 1600, two agricultural products became especially important for Portugal's early modern growth: maize and port wine. We now consider each in turn.

[41] Letter circa 1553 from Castanheira to John III, in Cruz (2001).

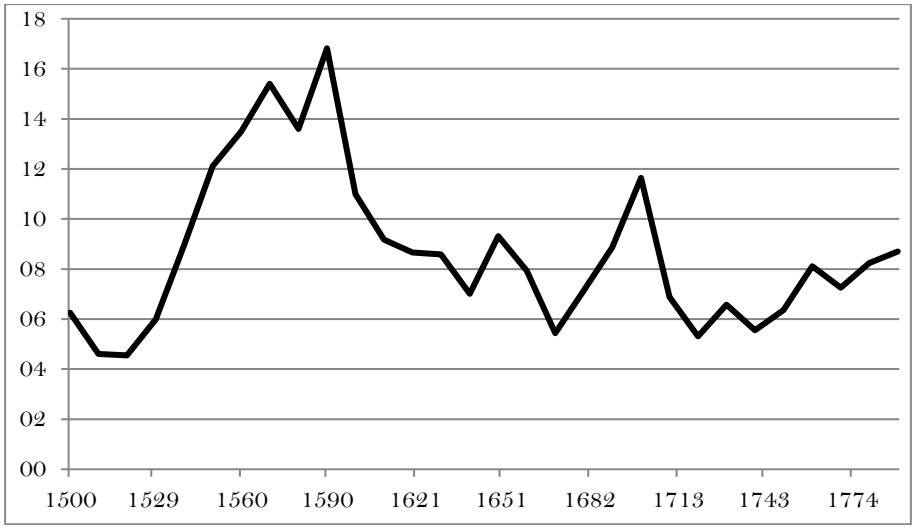

Figure A3. Rent-wage ratio, 1500-1850. Source: Reis (2016).

Maize

Maize (*zea maïs*) is a prime example of 'Columbian exchange'.[42] It arrived in Portugal in the early-sixteenth century but it only started replacing other grains like wheat and rye a century later.[43] By 1700, in the provinces most suited for its cultivation –Entre-Douro-e-Minho and Beira and parts of that of Estremadura - its share in total human cereal consumption was close to 20 per cent. By 1750, this had risen to between 50 and 60 per cent and around 1800 it had almost completely displaced predecessors, reaching a peak of 80-85 per cent. At this point it stabilized. To proxy annual maize output in Portugal the best proxy is the tithe of the bishopric of Vizeu, in Beira. It is displayed in Figure A4 and adopted here since it is corroborated by several credible benchmarks.[44] This allows us not only to plot the course of corn production, but also to gauge its impact on the economy as a whole, given that more than 60 per cent of Portugal's population lived in this area and eventually based its diet on this foodstuff. The relevance of maize was thus not so much that it increased absolute per capita food output significantly. Rather it was that, under conditions of an expanding population, it did so in a far more efficient way and thus fueled a rise in GDP per capita. There were several reasons for this.

[42] The seminal work on the Columbian exchange is Crosby (2003). For an encyclopedic view of American corn, see Messer (2002).

[43] The start of mass maize cultivation has been much debated but has now been settled by Almeida (1995) and Neto (2016). Two reasons determined its timing of diffusion. Severe harvest losses in the 1590s led to high grain prices and hunger, and drove a desperate search for cheaper carbohydrates. Maize, an inferior and cheap good, became for many people the only option. The second, suggested by paleo-botanic studies, claims that early strains of American corn were unsuited at first for profitable cultivation in Western Europe. It was not until a century later that successive hybridization and selection made appropriate ones available to farmers (Dubreuil et al. 2006).

[44] The time series for the Viseu grain tithes are from Oliveira (1990 and 2002) and begin in 1550. They only discriminate American corn (*milhão* or *milho graúdo*, in Portuguese) from 1665. Two contemporary national surveys of agricultural conditions are furnished by Costa (1706-12) and the manuscript *Memorias paroquiais* (1758), in the National Library of Portugal. Both are qualitative. For later regional and national quantitative benchmarks, see Lains and Sousa (1998), Sousa and Alves (1997) and Justino (1988).

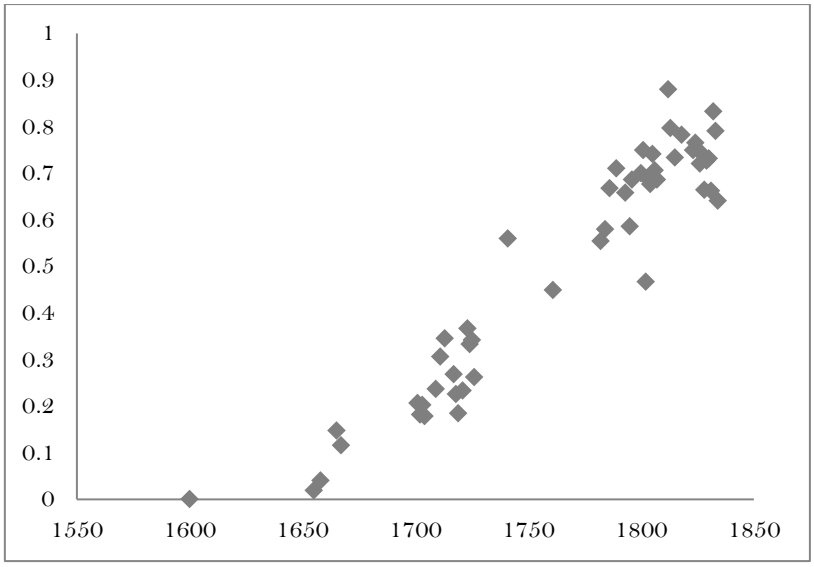

Figure A4. Ratio of tithes by volume of maize to total grain in the bishopric of Viseu, 1600-1834. The earliest observation (1600) is assumed as 0.1 per cent. Sources: see text.

The first relates to the unusual aptitude of this new crop, comparatively, to save on land, a factor then rapidly becoming scarce[45] Given its need for abundant watering, by means of irrigation, and for intensive husbandry, including manuring, the yields of this plant, whether measured in output per seed or output per hectare, were far higher than those of competing cereals. In both eighteenth century Minho and Beira, the ratios between them typically varied between three and four to one, by either standard (Sousa and Alves 1997; Campos 1989). Moreover, being a spring/summer crop, growing maize freed up much land for the rest of the year and became the basis for a number of rotations which included winter cropping and pastures for the more numerous teams of oxen required for its cultivation (Amorim 1996).[46]

Land was not the only factor which farmers saved on, however. Labor costs per unit of output were also reduced owing to the fact that the higher land yields permitted raising efficiency in several field operations (e.g. ploughing). On the great Cistercian monastery of Tibães, in the heart of the maize region, the average number of days needed to produce an *alqueire* (13.9 litres) of wheat was 21.2. In maize, it was only 8.7 (Oliveira 1980, p. 49). Since their respective calorie contents were similar, the average price of wheat tended to be 50 per cent higher than that of American corn. As the relative importance of maize in basic consumption rose to a position of dominance, it became increasingly cheap to feed the Portuguese population. Other things being equal, this implied raising per capita GDP.

Further gains of a similar kind lay in in the significantly different demand of maize for labor, which led to a rise in the average yearly effort per worker and a shortening of the periods of rural unemployment so common in the early modern agricultural calendar. Two circumstances were responsible for this. One was maize's idiosyncratic need for a much higher labor input per unit of land compared to other kinds of arable production. This arose from its need for more frequent weeding and hoeing during the vegetative cycle and, during the hot season, for the heavy toil associated with watering.[47]. The other was that these tasks were distributed

[45] For a summary of the technical innovation which underpinned the 'maize revolution', see Neto (2016).
[46] Campos (1989: 112) estimates that on the lands of the monastery of Arouce, the population of oxen tripled during the eighteenth century.
[47] For the multiplicity of operations during the cultivation cycle of this crop, see *Mappa* (1794), a contemporary expert's view. Current labour requirements for cultivation were swollen by non-periodic needs for infrastructural

more evenly over time and this flattened the demand for labor and making its peaks less frequent. As a result, with more days of employment per annum available to the work force, even if daily wages stagnated or fell, income per capita was still bound to rise. Overall, this represented an effect akin to that of an "industrious revolution". Thus, for as long as maize's share of grain output continued to expand, this was increasingly felt in the Portuguese agricultural economy.[48]

Besides plentiful labor, water and suitable land, Portugal's "maize revolution" was enabled by two other factors. One was the substantial capital input required to finance irrigation systems and field terracing. The other was the institutional framework in which this transformation took place and which supplied in a stable fashion the incentives essential to this activity. The achievement of this major transformation of the agrarian system over the seventeenth and eighteenth centuries indicates that both Portugal's society and economy were capable of responding to growth opportunities, rather than blocking them (Serrão 2009).

As regards capital formation, several micro-studies show that informal credit markets were capable of mustering, with apparently little difficulty, the financial resources from monasteries, charitable bodies, lay lords, and lay lords needed to build up the main infrastructures (Amorim 2006). This was complemented by extensive self-investment in time and labour by their tenants in small scale projects (Maia 1991; Campos 1989). Financial conditions were made even easier during most of the seventeen hundreds, the great era of maize expansion, thanks to the massive gold inflow from Brazil, an ensuing persistently buoyant credit market and a downward secular trend in national interest rates (Costa et al 2014).

On the institutional side, barriers to economic progress appear to have been less harmful than usually supposed (Amaral 2012). Two aspects deserve attention. One was the tenancy regime to which the majority class of small farmers in the northern half of Portugal was subjected since time immemorial (Amorim 1997). This was an emphyteutic contract which normally lasted for "three lives" - in practice, a duration of 30 to 50 years - and earned the lord a small fixed fee (*foro*), as well as a more significant fixed share of the harvest (*ração*), from a tenth to a third). For a peasant aiming to innovate and invest in improvements, a long lease with safeguards for descendants and a stable share of output was attractive. For the lord of the land, these leases curried no less favour because they offered a fixed, generous and inflation-proof crop sharing arrangement with a long duration. It naturally strengthened their interest in supporting any form of agrarian progress which could raise their real income in this way (Neto 1997).

The second institutional condition of maize's success was the establishment of local rules that ensured the efficient distribution of water to cultivators and an equitable assignment of responsibility among them for the maintenance of irrigation systems.[49] How they came about is not sufficiently known although their effectiveness is obvious. Notwithstanding the claims of agrarian historians regarding the conflictual nature of Ancien Regime society, over the long run these arrangements appear to have functioned satisfactorily. There were three reasons for this. They were decentralized; their norms tended to blend together, in each case,

---

development, mainly for terracing and irrigation. The monks of Grijó, for example, built two aqueducts in the eighteenth century, respectively a half and a quarter of a league in length (Amorim 1997). One league = 3 miles.

[48] The rise in long-term rural prosperity which inevitably ensued is brought to lig ht in the data regarding peasant housing. From the late seventeenth to the late eighteenth centuries, there was a pronounced rise in the share of two-storied and tiled houses and a fall in that of one-story and thatched ones. Mota (2006) and Ribeiro (1989).

[49] Examples of these arrangements, which might bind up to several hundred participants and involved intricate formal and semi-formal provisions and round-the-clock watering schedules can be found in Maia (1991), Mota (2006), Oliveira (1979), and Ribeiro (1989).

national water laws, municipal regulation, local custom and agrarian contracts (Amorim 1996). The strongly hierarchical institutions of Portuguese rural society seem to have provided the efficient means to adjudicate conflicts and enforce decisions (Magalhães 2010).[50]

In summary, once a garden plant, the advantages of converting maize into a field plant were manifold. Its yields were considerably higher than in the case of other grains, its calorific content per kilogram was 30% greater, and its unit costs of production were lower. In addition, it required more labor per hectare, was less sensitive to climate fluctuation, and could be used for many different purposes. Adopting maize involved a learning curve for Portuguese peasants, but not a steep one since farmers were already familiar with millet. It also called for a reorganization of the field system, the creation of micro irrigation facilities and therefore a certain amount of investment, both physical and in terms of coordination. While the exact timing of the spread of this crop is little known, it is clear that around 1600 its share in total grain output was small and that by around 1800 it had reached its long term ceiling, attaining over 60% of national grain production towards the middle of the nineteenth century (Lains and Sousa 1998). In-between these benchmarks, evidence from local histories points to a fairly rapid spread throughout the 1600s and the first half of the 1700s (Oliveira 1990, 2002). Not surprisingly, a national survey of parishes in 1756 (*memórias paroquiais*) shows qualitative but convincing evidence that maize had by then come to play a leading role in a considerable part of the country, in particular where conditions were best suited for it (Entre-Douro-e Minho, Beira, and parts of Estremadura). Although this spread continued thereafter, it is likely to have been slowing down, as good land with a potential for irrigation became scarce. The beneficial effects of maize on agricultural production were probably losing steam.

Port wine

Viticulture and the production of wine in Portugal go back to Roman times, and were as common as grain cultivation. For at least part of the early modern period, Portuguese wine output can be estimated with some confidence from consumption data, using population figures, and foreign trade statistics. Its two basic components – ordinary and fortified wines - are displayed in figure A6. During 1680-1850 total output in volume terms rose at an annual rate of 0.4 per cent. In the late seventeenth century, however, a dramatic expansion took place in the form of an entirely new export-focused sub-sector, namely port, i.e. fortified wine. This rose from almost nothing, in the 1680s, to a peak in 1800 equivalent to some 40 per cent of all wine production, implying a remarkable 3.7 per cent annual growth over the period. In a relatively short time, it became the country's second engine of pre-industrial economic dynamism, along similar lines to those of maize. The seventeen hundreds were the 'century of Port'[51].

[50] Oliveira (1979, vol.1: 180-2) shows how in Tibães issues regarding water and enclosures were discussed by a council at which administrators from the monastery and farmers, large and small, were present.

[51] To infer ordinary wine consumption/output, we assume that hardly any of it was sent abroad and that adults annually drank one hectoliter each, except for urban residents for whom this was one and a half hectoliters (Martins 1998). Export figures represent the total output of port, which was not consumed domestically. They are also from Martins (1990). When we aggregate the two varieties, we treat one litre of Port, which had a much higher value added and alcoholic content, as equivalent to two litres of ordinary wine. Their price ratio was usually 2:1 too. Direct estimates of national wine output are available for 1772-1850 (Martins 1998) and are drawn from not always reliable fiscal records. They underestimate consumption volumes as expectable, but track them quite well.

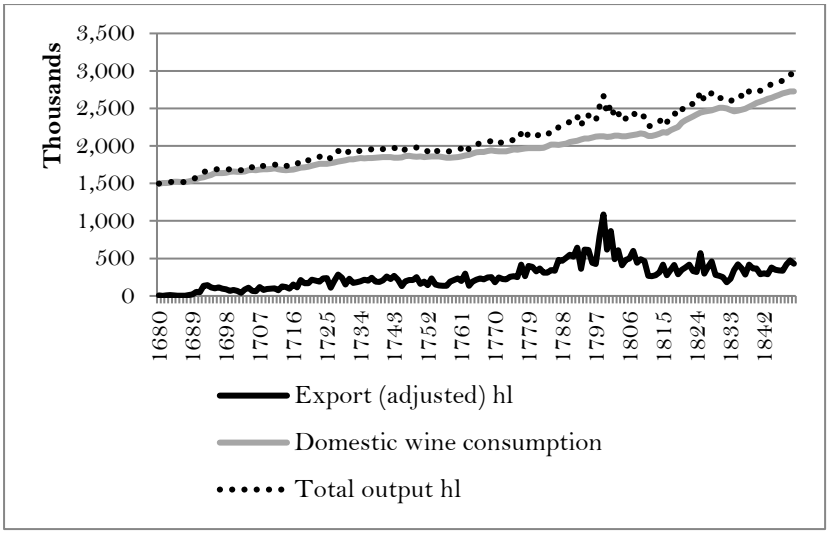

Figure A5. Portuguese wine output 1680-1850: total, ordinary and fortified (in thousands of hectolitres). Sources: see text.

The boom in port was due to three main factors. One was the decline, to a point of virtual exclusion, of France as the traditional supplier of wines to Great Britain, either by outright prohibition, in times of war, or stiff tariff differentials from the 1660s to the late eighteenth century. A combination of two British policy strands lay behind this outcome. One was the mercantilist concern to lessen trade dependence on France. The instrument for this in the case of Portugal was the 1703 Methuen Treaty, of Ricardian fame, which regulated the exchange of English woolens for Portuguese wines (Cardoso et al. 2003).[52] The other was a long-term fiscal strategy to divert domestic alcoholic demand for the upper classes from light French wines towards heavy Iberian ones, and, for the masses, towards British beer and spirits (Nye 2007). As a consequence, Portuguese wine exports to Britain shot up and their share rose dramatically. By the 1710s, it amounted to around 50 per cent of this market, while France's, which had been circa 70 per cent in the 1680s, dropped to 5 per cent. By the end of the century, Portuguese sales had reached nearly 70 per cent, with the rest of British imports originating chiefly in Spain (Francis 1972).[53]

A second factor was Portugal's capacity to take advantage of this exceptional opportunity and thus gain the preference of 'the world's most profitable wine-importing nation' (Bennett 2001: 150). To achieve this meant developing an entirely new type of alcoholic beverage which would satisfy and habituate British palates, and remain stable and storable over long periods of time, as required by international trade (Unwin 1996). Port was made from grapes grown on the rugged banks of the river Douro, far from the coast. Its chief novelty lay in its being one of the first wines to be fortified with vinous brandy and, thus, to be able to travel successfully. Its journey from the vineyard to the consumer was long and difficult, down the Douro to Oporto and then on to Britain. To cope with it, a complex process comprising storage, blending and quality control had to be developed. At the same time, the distinctiveness and excellence of the product required the assimilation of a range of innovative techniques, of cultivation, farm management, vinification and processing. These began to emerge in the late

[52] Diplomatically and militarily there was also an Anglo-Portuguese realignment against France and Spain. The Portuguese empire in America and its Atlantic sea lanes were given protection by Great Britain, who in return gained access to the burgeoning market in South America and to the strategically-located Portuguese coast in the event of war in the Atlantic.

[53] This rose to 80% briefly in the 1740s (Costa et al 2016, p.176).

sixteen hundreds and were still being improved a century and a half later (Martins 1997; Pereira 1998; Amorim 1996).

The third determinant of this expansion was the elastic supply of production factors, which permitted sustained rapid growth without erosion of marginal returns. In the case of land, that of the Douro valley was far from ideal for anything beyond grazing and a little grain. It was remote, steep, rocky, dry and harshly exposed. Once, however, it had been terraced, its rocks broken down and roads built through it to drain the produce, it became highly valued for the commercial cultivation of grapes. Since its alternative uses were scarce and the capital cost of constituting vineyards was high, land in its raw state in its natural condition was plentiful - indeed, in the course of time the danger was that the region might overproduce.

Although labor-intensive, for most of the year port farms, which were typically small units (Martins, 210, p. 124) could rely almost entirely on the work of family members. Ribeiro (1986) has claimed that in wine-dedicated areas, labor peaks were not exaggerated and inhabitants were fully active two-thirds of the year. In this particular case, there was, moreover, an enormous non-seasonal effort of terracing and planting, but this could be done by migrants, as happened also at harvest time. The latter were easily available owing to the proximity of the two provinces with the most vigorous demography of the early modern period - Beira and Entre-Douro-e-Minho (Palma and Reis 2015).

Finally, port production called for heavy investments in order to establish slowly maturing vineyards, open roads, acquire modern processing equipment and finance storage. This was satisfied from sources similar to those which backed the development of maize. There was an important additional player here however. Oporto British merchants, with their significant connections to London, had a strong interest in funding Douro farmers, a financial link which fostered valuable stable commercial ties between the two parties. As one of the former wrote at the time, 'without these advances the cultivation of the vineyards could never have arrived to the extent it has' (Bennett 1992: 33). Finally, one must not forget the powerful already noted impact of the Brazilian gold rush on the national financial system, which served the Douro wine sector as much as it did the surge of the maize economy.

The port and maize economies were different in a variety of ways. One of them was their natural environments which were completely unalike. The former was a perennial crop grown under a system of dry farming, whereas the latter was a heavily watered, annual one. Port was highly concentrated geographically, almost a monoculture (Martins 1998: 55). Maize was part of a pluricultural system of cultivation. Thirdly, their markets were quite distinct. Port was a high value-added product to satisfy an elite of distant consumers. Indian corn was a cheap, undifferentiated commodity consumed by the local masses.

Port and maize also shared certain common traits, however, which are fundamental for our argument that the Portuguese economy and society were capable of driving prolonged surges of intensive growth. One of these was a capacity, based on innovation and a stock of related human capital, to respond successfully to exogenous opportunities.[54] In both cases, fortunately, this affected sizable parts of the economy. Another was the possibility of sustaining these surges thanks to appropriate factor combinations. Irrigation, terracing and other heavy investments helped save costly and scarce land by shifting to more capital intensive production. A greater intensity of labor inputs and their better distribution over time helped resolve

[54] From this point of view we go against much of the literature on Portugal. It does not seem entirely correct to argue that Portugal was 'characterized by the lack of any breakthrough in agricultural techniques in the 1700s ' (Costa et al (2016, p. 171).

the welfare problem caused by a plentiful and ever expanding population. The outcome was that considerable parts of Portuguese agriculture experienced a type of 'industrious' revolution at this time.

The empire

The contribution of early modern empires to metropolitan growth and development has long been the subject of debate in the economic history of this era though the scale and sign of this effect still remain a moot point. In the case of Portugal, which had one of the oldest and most extensive overseas dominions, the consensus has been that overall this impact was barely beneficial, if not actually negative. The literature has inclined towards the notion that this country's benefits from overseas were indeed much smaller than those obtained by Britain and the Netherlands. This fact has often been regarded as part of the explanation for the long-term economic divergence between the former and the latter (Acemoglu et al 2005).

The contribution of empire to the metropolitan economy must have been small in the empire's early phase. This is suggested by the very small trade volumes compared with the overall size of the economy. For instance, Table A4 (which focuses on the Eastern Empire) shows the revenue from Portuguese sale of Asian goods in European markets during 1581-1640. As we can see, it represents a tiny fraction of Portuguese GDP over this period. Additionally, the table shows gross revenues, but profits must have been considerably smaller.

	Total Revenue in guilders	Total Revenue, in Reais	Average nominal GDP in Reais	Revenue / GDP
1581-90	5894	848057.6	63811441135	0.0013%
1591-1600	3750	539568.3	67912430394	0.0008%
1601-10	4844	696978.4	74332550496	0.0009%
1611-20	5333	767338.1	73880356629	0.0039%
1621-30	2258	324892.1	88094184199	0.0037%
1631-40	1487	213956.8	92793061028	0.0023%

Table A4. Portuguese revenue from the sale of Asian goods in European markets. Sources: for the revenues, de Vries (2003, p. 86). For nominal GDP, the main text of this paper. We assume the exchange rate was 2.78 guilders = 1 cruzado for the entire period (given in de Vries 2003, p. 86, endt. 723, p. 103; instead, Denzel 2010, p. 93 gives 1.75 guilders per cruzado in 1661, which would lead to even smaller ratios). In turn, 1 cruzado = 400 reais.

Recent work by Costa et al. (2015), however, has employed new data and a dynamic model to quantify the magnitude of the effect of the empire on the mother country's economy. The results largely contradict the conventional wisdom, two of them being of particular relevance in terms of the present study. One is that among the group of 'Atlantic trader nations', Portugal was not one of the least, but in fact one of the most successful at extracting surpluses from extra-European possessions. The other is that, throughout the period from 1500 to 1800, the empire had a significant and steadily rising influence on Portugal's economy. In the course of the sixteenth century, in per capita terms, this was small when measured as a share of the level of real wages - it rose from 1 to 4 per cent. During the following century, it rose from 4 to 7 percent, and in the course of the eighteenth century from 7 to 23 percent (Costa et al 2015, p. 15-6). Thus, while it took time for the empire to generate a major effect, eventually it provided an impulse for growth which may have been of a similar order of magnitude to the dynamic advances achieved in agriculture. Behind this lay a complex process of long term development which again reveals a national social and economic capacity to respond successfully to external

challenges – in this instance, arising in Africa, Asia and America. It too required a considerable ability to innovate, to promote change, and also to allocate and organize effectively resources on a considerable scale.

IX - The econometric specification: some details

All data (in natural logs) have been tested for stationarity and structural breaks, which can be rejected at the usual levels of significance.[55] This is true for per capita GDP even if the time period is restricted to 1530 to 1755. The exception is, as visual inspection of the population curve suggests, the land-population ratio, for which a unit root with drift cannot be rejected at 5% and a unit root with trend cannot be rejected at 1% significance. The clear downward trend of the data suggests the latter is the correct choice, and for this reason we include a deterministic trend as a control in the regression.

Standard errors are Newey-West corrected. This estimator requires choosing a truncation parameter which corresponds to the number of lags up to which the error terms are allowed to be correlated in the variance matrix. Several rules for the choice of these lags have been proposed in the econometrics literature. We use five lags in the baseline estimates, which corresponds to the most conservative choice. The choice of a smaller number does not change our conclusions in any significant manner, however. In Table A5 we show the number of autocorrelation truncation parameters to be used in the Newey-West estimation of the variance matrix, according to several criteria. This justifies our selection in the econometric section of the paper.

Number of observations	$4(T/100)^{2/9}$ (Newey and West 1987)	$0.75T^{1/3}$ (Stock and Watson 2007, p. 607)	$T^{1/4}$ (Greene 2003, p.200).	any T Wooldridge (2009, p. 429)
T=321	5	5	4	1 or 2 (for annual data)

Table A5. Choice of the number of autocorrelation truncation parameters to be used in the Newey-West estimation of the variance matrix, where T is the number of observations.

X – Details about the gold series used as a control

The source for our gold series used in our regression is Morineau (1986). An alternative series, which we do not use because it starts only in 1720, is provided by Costa, Rocha and Sousa (2013), who also provide a detailed comparison between both series after 1720. Since in many years in the sample the quantity of gold imports equals zero, we have simply substituted all zeroes by the smallest positive quantity observed divided by 100. This seems to us a better solution than the more common solution of adding 1 to all the data, because that solution is unit-dependent; doing so, however, does not change our basic results. Finally, it should be said that only Brazilian gold is considered here though earlier, Portugal had imported much smaller quantities of gold from the Guinea coast. Further, notice that including contemporary gold

[55] It is also to be noticed that if the data is used in levels, it is non-stationary and per capita GDP and the population levels were cointegrated up to around 1755, but not after this date. (Because the super-consistency property associated with the existence of a cointegration vector, no controls were used.)

imports only accounts for impact effects but since these imports were highly persistent, it can also give a sense of the relative global magnitude for each period.

XI - Occupational distribution and structural change

We provide here a summary and update of the discussion in the online Appendix to Costa et al. (2015). A continuous occupational structure time series is unlikely to be available in the near future. We rely on a set of evenly spaced benchmarks linked by means of linear interpolation. We start in 1500 and continue at 50-year intervals all the way down to 1850. Our categorization does no more than distinguish between the two most basic economic sectors – agriculture and non-agriculture – since we lack consistent information to allow for a more detailed analysis. Some benchmarks can give a breakdown of "non-agriculture" into manufacturing, administration, trade, transport and so on, but not all of them.

We are unable to consider the active population separately from the rest of the population. Our quantification refers entirely therefore to the aggregate population of families dependent on a particular economic activity, without regard for whether their individual members were employed full-time, part-time or not working at all. We should note that the historical sources we employ, in particular tax records, are also organized on a family basis, never on an individual one, and mention only the occupation of the heads of households.

The first step in this exercise is to separate the urban population, defined as the inhabitants of agglomerations of more than 5,000 residents. We employ for this a single source, Bairoch (1988), which has two advantages. It provides complete coverage for the period considered and uses the same methodology throughout.

Nevertheless, care is needed in the employment of the data. Bairoch included in his aggregate estimate all urban centers irrespective of size. Instead we recalculate his aggregates by excluding all towns with less than 5,000 inhabitants. At the same time, we have recovered the residents of all the towns that Bairoch dropped from his count every time they were not mentioned in a given year in his sources, though they are known to have continued to exist. We assume that this was due to an error, omission or simply to a gap in the historical records, and not to a contraction of the population to a figure below the stipulated minimum.

Table A6 displays the best available figures for Portugal's urban population, defined as the total number of inhabitants of agglomerations of more than 5,000 residents. We employ a single source, Bairoch (1988), but we make an adjustment.[56] Bairoch included in his estimate all urban centers irrespective of size, and simply added them up to obtain "urban population". We want to exclude from the category of "urban" all towns having less than 5,000 inhabitants, hence we have left out all the locations which did not satisfy this requirement. At the same time, we have recovered the residents of all the towns that Bairoch dropped from his count every time they were not mentioned in his sources for a particular benchmark, though they are known to have continued to exist over this period. When this happens, we assume that it was due to an error or omission, and not to a contraction of the population in question to a figure below our stipulated minimum. We have therefore interpolated the "missing" inhabitants at the level observed in the count of the previous benchmark, as long as this was not less than 5,000 inhabitants.

[56] For different reasons, Álvarez-Nogal and Prados (2007) have established urbanization data for Spain which also departs from Bairoch's. Our correction is smaller than theirs, however.

	(1)	(2)
	total	urban
1500	0.906	0.155
1550	1.350	0.193
1600	1.857	0.242
1700	2.300	0.293
1750	2.359	0.429
1800	2.912	0.476
1850	3.412	0.607

Table A6. Portugal's total and urban population, 1500-1850 (in millions). Sources: col. 1 from Palma and Reis (2015); col. 2 from Bairoch (1988) revised.

Table A7 displays in columns 1 and 2 the two series obtained thus far – total population and urban population. Together, they provide the foundation for the rest of this section and enable us thus to track how the broad occupational distribution of the population evolved over these three and a half centuries.

	(1)	(2)	(3)	(4)	(5)
	total	urban	rural non agricultural	agricultural	total non-agricultural
1500	0.906	0.155	0.150	0.601	0.305
1550	1.350	0.193	0.220*	0.938	0.412
1600	1.857	0.242	0.322*	1.293	0.564
1650	2.000	0.267	0.472*	1.261	0.739
1700	2.300	0.293	0.692**	1.315	0.985
1750	2.359	0.429	0.680***	1.250	1.109
1800	2.912	0.476	0.840***	1.596	1.316
1850	3.412	0.607	0.529****	2.276	1.136

Table A7. Portugal's population: total and by sector (millions). Sources: those of Table A6; * is a linear interpolation based on Álvarez-Nogal and Prados dela Escosura (2007); ** is from Montemor-o-Novo, Portalegre, Castro Marim and Tavira-Cacela's archival data; *** inferred from Sá (2005); **** is from Reis (2005).

These are presented in Table A6, which has columns for total, urban, rural non-agricultural, agricultural and total non-agricultural population. To arrive at these figures, our reasoning starts with the observation that only a small part of the agricultural labor force in Europe lived in urban units with a population of more than 5,000 and thus represented a very small proportion of the total urban population (Allen 2000, Van Zanden 2005). These authors have assumed therefore, as a reasonable simplification, that in practice this segment can be represented as equal to zero.[57]

The next task is to arrive at the share of the non-urban population that was engaged in agriculture and was *ipso facto* the "agricultural population" of the country. For 1500, we endorse the assumption that the occupational structure in Europe, up to the early-sixteenth century, was roughly homogeneous and that agriculture occupied about 80 percent of the rural population (Wrigley, 1985, Allen, 2000). The remaining 20 percent corresponded to the rural

[57] More recently, Álvarez Nogal and Prados de la Escosura (2007) claimed that, in the case of Spain's urban network, there was a significant presence of "agro-towns". This would invalidate that assumption and has led to a much more complicated treatment of the data, so as to separate the "urban agricultural" component. In the case of Portugal, we have chosen to ignore this problem since the only region - Alentejo - where agro-towns were present represented only a small proportion of the national population. We therefore accept that the urban population as defined was an all non-agricultural population.

non-agricultural population.[58] At the end of our period, we have fairly reliable data from Reis (2005) for 1800 and 1850, and, for 1750, from Sá (2005).

We also have an independent 1700 benchmark, which, however, rests on weaker evidence. It is based on tax rolls compiled around this date, containing detailed, reliable information on occupations of heads of families. They pertain to rural townships (i.e. with less than 5,000 inhabitants) and their respective hinterlands. One of them (Montemor-o-Novo) is from Alentejo. This was a lightly populated, predominantly rural province in the south, dominated by "agro-towns", and as such was not particularly representative of the country as a whole. The other two cases come from the Algarve (Castro Marim and Tavira-Cacela), a coastal region further south, with a higher density of population, many small holders and a complete absence of "agro-towns". Altogether, it would have been much more like the rest of the country north of Lisbon. [59] Despite the differences between these two regions, in 1700 their respective shares of non-urban population engaged in agriculture were very similar. They were within a narrow band from 64 to 67%.

Pending fresh evidence from additional sources, we have opted for the mean value of 65.5%.[60] The remaining benchmarks – 1550, 1600 and 1650 – are derived by means of a log-linear interpolation as used by Álvarez-Nogal and Prados de la Escosura (2007) for Spain for the same years.[61] In Table A8, we present the absolute values of Table A6 converted into shares of total population. The advantage of this lies in allowing us to perceive, at a glance, the shifts in categories in the socio-economic population categories and thus grasp structural change over time more readily. It shows, for example, the long term weakness of the thrust towards urbanization, which picks up only in the mid-eighteenth century (col. 1), a clear sign of delayed modernization.

[58] These proportions are confirmed by the scarce evidence available for late-medieval Portugal. According to Godinho (1968-72), in Alenquer, a small provincial center, at the end of the fifteenth century those engaged in agriculture represented 74% of the entire population. In the case of Torres Vedras, a small town and its hinterland, in 1381, the "non-agricultural population" came to 33% of the whole (Rodrigues 1995). Further back, in 1369, in Arruda dos Vinhos, also not far from Lisbon, 86% of all households were of farmers, the non-agricultural population representing therefore 14% (Marques, 1980, p. 126-31).

[59] The chief town in the county of Montemor-o-Novo had a population of about 3,500 out of a total of 7,300 for both the town and its hinterland. (Fonseca 1986). In Castro Marim these figures were 632 and 1,928, while in Tavira-Cacela they were 1,848 and 2,660. Their agricultural populations were 64 and 67 % respectively (we include 74 fishermen in Tavira, an important fishing port, and treat "agriculture" here as the "primary sector"). In 1725, Portalegre, a town of about 7,500 inhabitants (1480 households), had a rural hinterland of about 5,000, where 78% of the population was engaged in agriculture. In the town itself, between 20 and 30 % of the labor force was also agricultural. In all these cases we have treated the usually fairly substantial category of individuals with a "non-identified occupation" as belonging to the category of those living off agriculture.

[60] A fourth similar tax roll is available for the county of Portalegre, also in Alentejo, for 1725.

[61] This interpolation is a better solution than those used by Wrigley and Allen who were obliged to cover, in this manner, two and a half centuries (1550 to 1800) instead of one and a half, as here (1550 to 1700).

	(1)	(2)	(3)	(4) = (1) + (2)	(5) = (1) / (4)
	Urban ratio	Rural non agricultural	Agricultural	Total non-agricultural	Urban/ total non-agricultural
1500	0.171	0.166	0.663	0.337	0.508
1550	0.143	0.163	0.695	0.305	0.467
1600	0.130	0.173	0.696	0.304	0.429
1650	0.134	0.236	0.630	0.370	0.361
1700	0.127	0.301	0.572	0.428	0.297
1750	0.182	0.288	0.530	0.470	0.387
1800	0.163	0.288	0.548	0.452	0.362
1850	0.178	0.155	0.667	0.333	0.610

Table A8. Portugal: Population shares of total by occupation. Sources: same as for Table A7; urban corresponds to pop. >5,000.

It suggests equally that the imperial expansion of the sixteenth century did not a have significant impact on the economic weight of agriculture (col.3; Costa, Palma and Reis 2015) though, in contrast, it did so during a good part of the eighteenth century's colonial expansion in Brazil. It also brings to light the fact that the higher productivity secondary and tertiary sectors (col. 4) gained ground for two and a half centuries from 1500 to 1750, but slowed their contribution to economic modernization after that date. It reveals the apparent steady ruralization of manufacturing activity during the two first centuries considered here and its re-urbanization in the course of the following 150 years (col.5).

XII - The proximate determinants of the 1750-1850 great reversal?[62]

Exogenous influences

Earthquake.[63] In 1755, Portugal was visited by a violent earthquake which razed a large part of Lisbon and caused extensive damage throughout the rest of the country. Loss of life and human capital are represented by the 20 to 30,000 who perished and have never been valued. In Lisbon, 11,500 dwellings and hundreds of public buildings were destroyed as well and many types of productive assets (including money and gold) disappeared. Total material losses have been estimated at 64-72,000 contos and represent 44.4 to 50.0 percent of annual GDP.[64] An enormous investment was subsequently needed to replace all this destruction. It is estimated that it was not until the 1780s that Lisbon was rebuilt (Pereira 2009, p. 488). Costa et al (2016, p. 211) consider that 80 percent of this expenditure was financed from the stocks of gold held as savings by the population.

The institutional fall-out from this episode has been assessed in terms of the positive effects arising from the rise to power of the marquis of Pombal, in the wake of this crisis (Pereira 2009). The social and economic reforms which he undertook fostered trade monopolies, educational and fiscal reforms. They also protected and regulated major industrial projects and encouraged the ascent of a new business-oriented plutocracy. The view that such changes were beneficial in the long run is opposed by Madureira (1997), who claims that pombaline policies were costly as well as promoting inefficiency. By the early nineteenth century they had been dismantled, having their time, there not being much left of their positive consequences.

[62] In this discussion, we focus on proximate causes and leave out of this account the fundamental ones relating to culture, institutions, economic geography, and human capital.
[63] See Pereira (2009) and Serrão (2007).
[64] Calculated from the loss estimates by Pereira (2009, p. 479) combined with the GDP estimate (144,000 contos) from Figure 1 of the main text.

Napoleonic invasions. A consequence of Anglo-French rivalry in which Portugal was a mere pawn, the invasions lasted from 1807 to 1811 (though the official peace was only attained in 1815). The actual military and administrative occupation of the national soil by the French was short and superficial, lasting only a total of a few months altogether. Heavy losses of life and property have been reported but may have been exaggerated somewhat. There is no balance sheet of deaths and material destruction, and no proper estimate has yet been attempted. Thus, there is no reliable figure for either direct or indirect losses. The approach used here instead is indirect and subtracts actual yearly figures of GDP for the period 1808-1914 from the corresponding trend values measured over the interval 1750-1850. The total comes to 54 per cent of GDP but is an overestimate since we cannot separate the losses directly caused by war from those generated by economic dislocation arising as a result of political and diplomatic events such as Portugal's loss of its empire. The latter should not be considered a direct consequence of war since it would probably have happened even if the French armies had not invaded Portugal. It is practically certain that Britain would have put an end to Portugal's colonial pact with Brazil and put an end to the commercial privileges enjoyed overseas until then by the Portuguese.

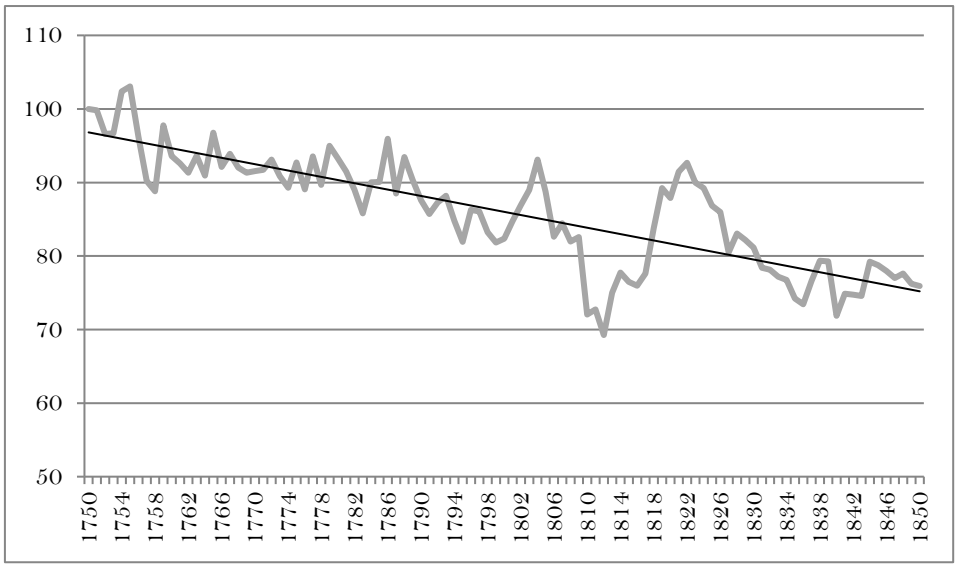

Figure A7. Portuguese per capita GDP, 1750-1850 (index with 1750=100).

In the medium run, it is arguable whether the net economic effect on Portugal of the Napoleonic wars made such a great difference. Once the peace had returned and commercial circuits been re-established after 1815, there was a phase of post-war catch-up growth between 1818 and 1828 (Figure A7). Its cumulated value was close to the value of losses in war time.

In the long run, a note should be added to this regarding the fact that the institutional transformations experienced as a result of the occupation by France of certain countries, like Germany, Italy and the Netherlands, hardly occurred in Portugal. The positive impact of such transformations during the first decades of the nineteenth century in much of Europe, as a result of induced institutional modernization, cannot be claimed by the latter country. Such reforms took root in Portugal but only after the 1850s and their economic effects by then are difficult to measure or even to trace (Amaral 2012).

Endogenous influences

The three dynamic forces for growth of the preceding surge - maize, port wine and empire – seem to have gone more or less into decline during the great reversal, when they ceased to generate sustained positive macroeconomic effects. Their respective shifts, from favorable to unfavorable, had quite different timings during this century regression. Yet their global effect, combined with the sustained pressure of population on resources, was enough to cause a trend decline in per capita GDP over several generations, which proved impossible to reverse. Innovation had brought these forces into existence but could not ensure their continuing success in the face of exogenously imposed adversity. In the case of maize, a natural resource barrier definitively stifled its progress of more than a hundred years. In the case of port wine, there was only one market for this notable product and when the policies that regulated it became adverse to Portuguese exports there was nothing that producers or the state, which protected these interests, could do to overcome it. The colonies, from which Portugal had gathered over the centuries so many economic benefits, could only be maintained for as long as it was in Great Britain's interest to protect from its enemies the independence of the mother country as well as the sea lanes which were the sinews of this mercantilist empire.

Maize. During the first half of the eighteenth century, the output of this sector must have grown at more than 2.0 per cent per annum. In the second one, its rate of expansion was a fifth of this and after 1800 it stagnated altogether. By 1800, in the principal maize region of Portugal this crop was feeding three quarters to four fifths of its population but natural resources for further increases had clearly run out. There are several symptoms of declining marginal returns to be observed. Official reports were complaining that farmers no longer distinguished between suitable and unsuitable soil when breaking new land for maize, a sign of its increasing scarcity, and cultivation was demanding more labour (Capela 1987). New irrigation systems were becoming costlier to install and harder to set up, a fact corroborated by increasing complaints that conflicts over water distribution were becoming more prevalent (Sousa and Alves (1997). Other critical inputs, such as oxen for ploughing and vegetable manure were not giving as good results as used to be the case (Campos 1989).

Port wine. Port forged ahead during the first decades of the eighteenth century by carving out a significant share in the only international opening for it available, the British market, where it enjoyed preferential status. A long period of stability ensued, during which port was able to fight off the competition, but further growth only became possible again in the 1770s thanks to a lowering of British tariffs. This led to a tripling of exports and thus of output between this decade and the 1810s, and consequently to a favourable impact on per capita GDP. The government, under the marquis of Pombal, had introduced far-reaching policies in 1765 for this sector, to protect it from the difficulties it encountered in the 1750s. This was a crisis of overproduction which occurred in the familiar context of a product with a long investment cycle and a highly inelastic demand. It degenerated into a downward spiral of prices and quality, the only remedy for which was a demarcated area, to limit supply, and strict quality and marketing controls, which included a state-protected company to control the supply of the brandy needed for making port. The artificial nature of this situation was tested successfully when, in 1788, the demarcated region for port grapes had to be extended so that Portugal might satisfy the increased international consumption of this beverage without the danger of a second port crisis and a collapse in prices. This very positive situation (for the port sector and for GDP pc) lasted forty years but could not hide the essential fragility of what had seemed an exceedingly promising product. British consumption of bottled wines fell from 2.9 units per capita in the 1790s to 1.3 in the 1840s, by which time exports had returned to the level of the 1770s. Despite the originality of this product, its high value-added and the impressive estab-

lishment of the sector, the problem was that that though port was unique, it also faced a unique market.

Empire. Until the opening of Brazilian ports to the trade with friendly nations (i.e. Britain) in 1808, Portugal enjoyed all the economic advantages of heading a mercantilist empire, particularly during the second half of its last Early Modern reversal. Despite the decline of Brazilian gold extraction since the 1770s, the strong agricultural and commercial base of this colony's economy had still been sufficient to add, on this account, a significant contribution to the country's macroeconomic performance (Costa et al 2015). In the early 19th century, the effect on the home economy of the inversion of this situation has been a controversial issue which is not yet settled. It is hard to doubt that it cannot have been anything but negative. At the same time, the available evidence indicates that the downward adjustment of the Portuguese economy to the loss of the Brazilian market, owing to the arrival of a formidable new competitor, i.e. Britain, was only a gradual one. It may have stretched over two or even three decades (Costa et al 2016). This seems certainly true of the damage to Portuguese industry, which has been the focus of most of this debate. On the other hand, commercial and other economic ties between the former metropolis and the ex-colony apparently persisted to some extent quite far into the nineteenth century. This reinforces the idea that the political separation of Brazil certainly inflicted economic losses on the mother country but was less harmful than has often been believed.

Appendix references

Acemoglu, D., Johnson, S. and J. Robinson. (2005). The rise of Europe: Atlantic trade, institutional change, and economic growth. *American Economic Review* 95, 546-579.

Allen, Robert C. (2000). Economic structure and agricultural productivity in Europe, 1300-1800. *European Review of Economic History* **4**: 1-25.

Almeida, Luís Ferrand de (1995). Sobre a introdução e difusão do milho maís em Portugal. In Luís Ferrand de Almeida (ed.) *Páginas Dispersas. Estudos de História Moderna de Portugal* (Coimbra), pp. 229-259.

Álvarez-Nogal, Carlos and Leandro Prados de la Escosura (2007). The decline of Spain (1500-1850): Conjectural estimates. *European Review of Economic History* 11, 319-366.

Amaral, Luciano (2012), 'Institutions, Property and Economic Growth: Back to the Passage from the *Ancien Regime* to Liberalism in Portugal'. *Análise Social* **67**: 28-55.

Amorim, Inês (1996). Aveiro e a sua provedoria no séc. XVIII : 1690-1814: Estudo económico e um espaço histórico. Ph.D. dissertation, Universidade do Porto.

Amorim, Inês (1997). *O Mosteiro de Grijó. Senhorio e Propriedade, 1560-1720 (Formação, Estrutura e Exploração do seu domínio).* Braga: s.e.

Amorim, Inês (2006). Property and credit: the Misericórdia and Carmelites of Aveiro (seventeenth and eighteenth centuries). *Análise Social* **180**, 693-729.

Bairoch, Paul, Batou, Jean and Pierre Chèvre (1998). *Les Villes Européennes: Banque de Données et Analyse Sommaire des Résultats, 800–1850.* Geneva: Droz.

Barata, Filipe Themudo and Henriques, António Castro (2011). Economic and fiscal history. In José Mattoso (ed.). The historiography of medieval Portugal (c.1850-2010). Lisboa: Instituto de Estudos Medievais, UNL.

Bennett, Norman R. (1992). The wine growers of the upper Douro, 1780-1800. *The Portuguese Studies Review* **2**, 28-45.

Bennett, Norman R. (2001). "That indispensable article": Brandy and port wine, c.1750-1908. *Douro – Estudos e Documentos* **VI**, 149-160.

Campos, Maria do Rosário Castiço (1989) *Foz de Arouce no Século XVIII: Economia Agrária e Reconversão Agrícola*. Ph. D. Dissertation, Universidade de Coimbra.

Capela, José Viriato (1987). Entre-Douro e Minho 1750-1830. Finanças, Administração e Bloqueamento Estruturais no Portugal Moderno. Ph. D. dissertation. Universidade do Minho.

Cardoso, J. L. et al. (2003). *O Tratado de Methuen (1703). Diplomacia, Guerra, Política e Economia* (Lisboa: Livros Horizonte).

Costa, António Carvalho da (1706-1712). *Corografia de Portugal e Descrição do Reino de Portugal.* Lisboa: Oficina Real Deslandesiana.

Costa, Leonor F., Nuno Palma, and Jaime Reis (2015). The Great Escape? The Contribution of the Empire to Portugal's Economic Growth, 1500-1800. *European Review of Economic History* **19** (1): 1-22.

Costa, Leonor, Rocha, Manuela and Paulo Brito (2014). Money supply and the credit market in early modern economies: the case of eighteenth-century Lisbon. *GHES Working Paper 52.*

Costa, L., Rocha, M. and R. Sousa (2013). *O Ouro do Brasil.* Lisboa: Imprensa Nacional-Casa da Moeda.

Costa, Leonor and Jaime Reis (2016). The chronic food deficit of early modern Portugal: Curse or myth? Working Papers of GHES, Nº 2016/58.

Costa, Leonor, Rocha, Manuela and Paulo Brito (2014). Money supply and the credit market in early modern economies: the case of eighteenth-century Lisbon. GHES Working Paper, Nº 2016/52.

Crafts, N. F. R. (1984). Patterns of development in nineteenth century Europe. *Oxford Economic Papers* ***36***, pp. 438-458.

Crosby, Alfred W. (2003). *The Columbian Exchange: Biological and Cultural Consequences of 1492.* Westport, CT: Praeger.

Cruz, Maria Leonor García da (2001). *A Governação de D. João III. A Fazenda Real e os seus Vedores.* Lisboa: Centro de História, doc. XLIV, pp. 284-97.

Denzel, Markus A. (2010). *Handbook of World Exchange Rates, 1590-1914.* London:Ashgate.

Dias, José Alves (1985). Um documento financeiro do século XVII. *Nova História*, vol. VII, n. 3-4.

Drelichman, M. (2005a). The curse of Moctezuma: American silver and the Dutch disease. *Explorations in Economic History* **42**, 349-380.

Drelichman, M. (2005b). All that glitters: Precious metals, rent seeking and the decline of Spain. *European Review of Economic History* **9**, 313-336.

Dubreuil, P., Warburton, M., Chastanet, M, Hoisington, D. and A. Charcosset (2006). More on the introduction of temperate maize into Europe: Large-scale bulk SSR genotyping and new historical elements. *Maydica* **51**, 281-291.

Fonseca, Jorge (1986). Uma Vila Alentejana no Antigo Regime - Aspectos sócioeconómicos de Montemor-o-Novo nos séculos XVII e XVIII". *Almansor – Revista de Cultura* **4**, 119-207.

Francis, A. D. (1972). *The Wine Trade*. London: A. & C. Black.

Godinho, Vitorino Magalhães (1968-1972). *Ensaios*. Lisboa: Sá da Costa, 4 vols.

Greene (2003). *Econometric Analysis*. Prentice Hall.

Henriques, António and Reis, Jaime (2016). From horn to corn: The two regimes of Portuguese Agriculture, 1250-1850. Unpublished manuscript.

Justino, David (1988). *A Formação do Espaço Económico Nacional. Portugal, 1810-1913*. Lisboa: Vega, 2 vols.

Lains, Pedro and Sousa, Paulo (1998). Estatística e produção agrícola em Portugal, 1848-1914. *Análise Social* **33**, 935-968.

Maddison, Angus (2003). *The World Economy: Historical Statistics*. OECD

Maddison, Angus (2010). Statistics on world population, GDP and per capita GDP, 1-2008 AD. Groningen Growth and Development Centre. Accessed 9 of September 2016 from: http://www.ggdc.net/maddison/oriindex.htm

Maia, Fernanda (1991). Do mosteiro do Bustelo: Propriedade e produção agrícola no Antigo Regime (1638-70) e (1710-1821). Ph.D dissertation, Universidade Portucalense.

Malanima, Paolo (2011). The long decline of a leading economy: GDP in central and northern Italy, 1300-1913. European Review of Economic History **15**, 169-219.

Marques, A. H. de Oliveira (1980). Estratificação económico-social de uma vila portuguesa na Idade Média. In: Marques, A. H. de Oliveira (Ed.). *Ensaios de História Medieval Portuguesa*. Lisboa: Vega, 121-133.

Martins, Fausto (1997). Quinta da Vacaria.: A cultura da vinha num documento do século XVII. *Douro – Estudos e Documentos* **II**, 361-76.

Martins, Conceição (1998). Vinha, Vinho e Política Vinícola em Portugal: do Pombalismo à Regeneração. Ph.D. dissertation. Universidade de Évora.

Martins, Conceição (1990). *Memória do Vinho do Porto*. Lisboa: Instituto de Ciências Sociais.

Miranda, Susana (2016). Coping with Europe and the Empire, 1500-1620. In: *An Agrarian History of Portugal, 1000-2000. Economic development on the European frontier*, eds, Dulce Freire and Pedro Lains. Leiden: Brill, pp. 66-95.

Messer, Ellen (2000). Maize. In: *The Cambridge History of World Food*. Cambridge: Cambridge University Press, vol. 1, 97-112.

Morineau, M. (1985). *Incroyables Gazettes et Fabuleux Métaux: Les Retours des Trèsors Américains d'Après les Gazettes Hollandaises (XVI-XVII Siècles)*. Cambridge: Cambridge University Press.

Mota, Salvador (2006). *Cistercienses, Camponeses e Economia Rural no Minho na Era do Antigo Regime: O Mosteiro de Santa Maria de Bouce e o seu Dominio*. Lisboa: Imprensa Nacional-Casa da Moeda.

Neto, Margarida Sobral (1997). *Terra e Conflito: Região de Coimbra (1700-1834)*. Viseu: Palimage.

Neto, Margarida Sobral (2016). Conflict and decline, 1620-1703. In Dulce Freire and Pedro Lains (eds). *An Agrarian History of Portugal, 1000-2000. Economic development on the European frontier*. Leiden: Brill, 96-124.

Newey, W. K., West, K. D. (1987). A Simple, Positive Semi-definite, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix. *Econometrica* 55 (3): 703–708.

Nye, John Vincent (2007). *War, Wine, and Taxes: The Political Economy of Anglo-French Trade, 1689-1900*. Princeton: Prnceton University Press.

Oliveira, Aurelio de (1979). A abadia de Tibães. 1630-1813. Propriedade, exploração e produção agrícolas no Vale do Cávado durante o Antigo Regime. PhD dissertation, Universidade do Porto, 2 vols.

Oliveira, João (1990). *A Produção Agrícola de Viseu entre 1550 e 1700*. Viseu: Câmara Municipal de Viseu.

Oliveira, João (2002). *A Beira Alta de 1700 a 1840. Gentes e Subsistências*. Viseu: Palimage.

Palma, Nuno and Jaime Reis (2015). Reconstruction of regional and national population estimates using intermittent census-type data: the case of Portugal, 1527-1864. Unpublished manuscript.

Pereira, Álvaro (2009). The opportunity of a disaster: The economic impact of the 1755 Lisbon earthquake. *Journal of Economic History* **69**, 466-499.

Pereira, Gaspar and Costa, Natália (1998). Instruções para a cultura das vinhas e para o fabrico do vinho nas quintas de João Pacheco Pereira, antes da instituição da Companhia. Douro. *Estudos e Documentos* **III**, 161-75.

Pfister, Ulrich (2011). Economic growth in Germany, 1500–1850. Unpublished manuscript. Presented at the "Quantifying long run economic development" conference, University of Warwick in Venice.

Reis, Jaime (2005). O trabalho. In Lains, Pedro and Álvaro da Silva (eds.) *História Económica de Portugal 1700-2000. O Século XIX*. Lisboa: ICS, vol. 2, 119-151.

Reis, Jaime (2016). Gross agricultural output: A quantitative, unified perspective, 1500-1850. In: An Agrarian History of Portugal, 1000-2000. Economic development on the European frontier, eds, Dulce Freire and Pedro Lains. Leiden: Brill, pp. 166-196.

Ribeiro, Inês (1989). *O Couto de Ancede no Século XVIII. Senhorio e Exploração*. Master's dissertation: Universidade de Coimbra.

Ribeiro, Orlando (1986). *Portugal, o Mediterrâneo e o Atlântico: Esboço de Relações Geográficas*. Lisboa: Sá da Costa.

Rodrigues, Ana Maria (1995). *Torres Vedras. A Vila e o Termo nos Finais da Idade Média*. Lisboa: Fundação Calouste Gulbenkian - Junta Nacional de Investigação Científica e Tecnológica.

Sá, Isabel (2005). O trabalho. In: Lains, Pedro and Silva, Álvaro (eds), *História Económica de Portugal 1700-2000. O Século XVIII*. Lisboa: ICS, vol. I, 93-121.

Serrão, José Vicente (2007). "Os impactos económicos do terramoto". In A. C. Araújo et al. (Ed.). *O Terramoto de 1755: Impactos Históricos*. Lisboa: Livros Horizonte, 141-163.

Serrão, José Vicente (2009). Land management responses to market changes. Portugal, seventeenth-nineteenth centuries. In Pinilla, Vicente (ed.). *Markets and Agricultural Change in Europe from the Thirteenth to the Twentieth Centuries*. Turnhout: Brepols, 47- 73.

Silva, Célia Taborda da (1994). *O Mosteiro de Ganfei. Propriedade, Produção e Rendas no Antigo Regime (1629-83 e 1716-1822)*. Lisboa: Fragmentos.

Sousa, Fernando de and Alves, Jorge (1997). *Alto Minho: População e Economia nos Finais de etecentos*. Lisboa: Editorial Presença.

Stock and Watson (2007). *Introduction to Econometrics*. Addison-Wesley.

Unwin, Tim (1996). *Wine and the Vine: An Historical Geography of Viticulture and the Wine Trade*. London: Routledge.

Vilas-Boas, Custódio José Gomes (1794-5). Mapa da provincia d'Entre Douro e Minho... de par com as indicações económico-politicas tudo para servir à regulação das comarcas da mesma provincia, e outros objectos de utilidade publica' , manuscript in National Library of Portugal.

Wooldridge (2009). *Econometric Analysis of Cross Section and Panel Data*. MIT press.

Wrigley, E. A. (1985). Urban growth and agricultural change: England and the Continent in the early modern period. *Journal of Interdisciplinary History* **15**, 683-728.

Van Zanden, Jan Luiten (2005). What Happened to the Standard of Living Before the Industrial Revolution? New Evidence from the Western Part of The Netherlands. In *Living Standards in the Past. New Perspectives on Well-Being in Asia and Europe.*, eds. Robert C. Allen, Tommy Bengtsson, and Martin Dribe. Oxford: Oxford University Press.